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WINTERING BIRD POPULATIONS ON COAL STRIP-MINES IN NORTH CENTRAL ALABAMA

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The immediate physical impact of coal strip-mining on the terrestrial ecosystem is to create a site upon which primary ecological succession occurs. The speed, structure and pattern of this succession will be of increasing concern to mankind as the rate of coal extraction for energy increases through the next century. The consequences of coal strip-mining for the avian fauna are socially and biological important to our society. Only 3 studies have been published in the U.S.A. that quantify bird population successional patterns on coal strip-mined areas in comparison with "natural" habitats (Brewer 1958, Smith 1964, Karr 1968). All of these were in the northern U.S.A. and all concerned breeding populations. There have been no similar data describing winter faunas until this study.

Strip-mining for coal in the southern U.S.A., as is true elsewhere in the U.S.A., has exhibited spectacular increases in recent years. For example, the tonnage of coal in Alabama produced by this technique rose from 10 percent in 1963 to 44 percent in 1968 (Shotts 1971) and has since increased. Projections are that by the turn of the century there will be 0.5-million acres of strip-mine spoils in north central Alabama The values of this land for the continued production of wildlife is largely unknown. Therefore, attempts to measure these values have been incorporated into long range studies at Auburn University (Departments of Forestry, Agronomy & Soils, Zoology-Entomology) concerning the ecology and reclamation of coal strip-mines in Alabama. Evaluation of seasonal bird use patterns on naturally revegetated strip-mines in comparison with adjacent forested habitats is one aspect of these studies. The initial evaluation of the coal strip-mines as bird winter habitat is reported herein.

STUDY AREAS AND METHODS

Study Areas

Three study areas were utilized, one in each of three major coal fields in north central Alabama. Details concerning these fields can be obtained from Culbertson (1964). Specific locations of the study areas are in Table 1. Each unit consisted of a 5, a 15, and a 25-year old strip-mine in addition to either two or three adjacent, unmined, forested tracts. All mines had been abandoned with no reclamation. Time and manpower did not permit the censusing of but one type of natural habitat for use as a control. Consequently, all seven control plots were second-growth forests. However, no other major distinctive seral stages were immediately adjacent to two of the three study complexes. Approximately 90 percent of the region of the mines was covered by some type of mixed hardwood (predominantly *Quercus* and *Carya* spp.) and pine forest. The semi-mountainous region in question lies

Table 1. Study area locations for bird censuses on Alabama coal strip-mines, 1973-74

Mine name	Mine age class (yr.)	Mine size (acres)	*Location* Twp.-range	Section
		Walker County		
Sunlight	5	120	T13S, R6W	8
Sunlight	10	40	T13S, R6W	8
Sunlight	25	100	T13S, R6W	18
		Tuscaloosa County		
Kellerman	5	10	T19S, R7W	31
Kellerman	15	25	T19S, R7W	31
Brookwood	25	30	T20S, R7W	20
		Bibb County		
Piper	5	10	T24N, R10E	11
Piper	15	10	T22S, R5W	22
Piper	25	10	T22S, R6W	24

in a wedge between the Piedmont and the Cumberlain Plateau. Dynamics of natural plant succession on the Piedmont Province were intensively studied by Oosting (1942). It is probably the best available guide to the plant ecology of the Alabama study area. The terrain at Sunlight Mines in Walker County was mostly flat to rolling, while on the other two areas it was very hilly to mountaineous.

Bird Censuses

Bird censuses were conducted during December and January, 1973-74, on the nine mines and seven adjacent control plots. All birds possible were counted by sight and call on a square, 40-acre, surveyed plot in the center of each mine. Where the mine was not large enough to accommodate a 40-acre plot, the entire mine was treated as a unit. In reality, plots on the mines ranged from 10 to 40 acres. Concern over biases resulting from this variability are partially alleviated by the fact that Tramer (1974) found no correlation between bird species diversity and plot sizes between 13 and 60 acres, while the examination of Karr's (1968) data shows no correlation between breeding bird diversity and plot sizes ranging from 10 to 100 acres. All control plots were 40 acres, located at least 300 feet inside the forest to eliminate edge effect bias.

Each plot was systematically censused by counting all birds along parallel compass lines spaced at 165-feet intervals (after Stewart and Aldrich 1949). Each plot was censused 3 times, with the dates and times determined by random selection. Thus, the total censuses for each strip-mine age class was 9, with a total of 27 for all mines and 21 for all controls.

Significant differences were tested by Chi-square, with values of significance coming from Steel and Torie (1960).

RESULTS AND DISCUSSION

Species Diversity

Bird species diversity increased as strip-mines increased in age (Figure 1). However, the minor increase in diversity after 15 years, as shown by the data, did not test significant ($P < 0.05$). Neither was there a significant difference ($P < 0.05$) between either the 15 or 25-year old mines and the control plots, although the latter exhibited 19 percent more species than the 15-year old mine (Table 2). However, the larger sample size in favor of the control plots (7 vs. 3 plots) may be responsible for this difference. Highly mobile species with sparse populations, such as the wild turkey, would be more likely encountered with the greater plot numbers. The 5-year old mines were depauperate in species when compared with all other habitats measured.

Only one published study was located relating southeastern winter bird species diversity to natural seres. This was by Quay (1947) for the Raleigh, North Carolina vicinity. Quay found much lower overall diversity in his locality than we found in northern Alabama (Twenty-three to 25 species in his forest types, pine, and deciduous hardwood,

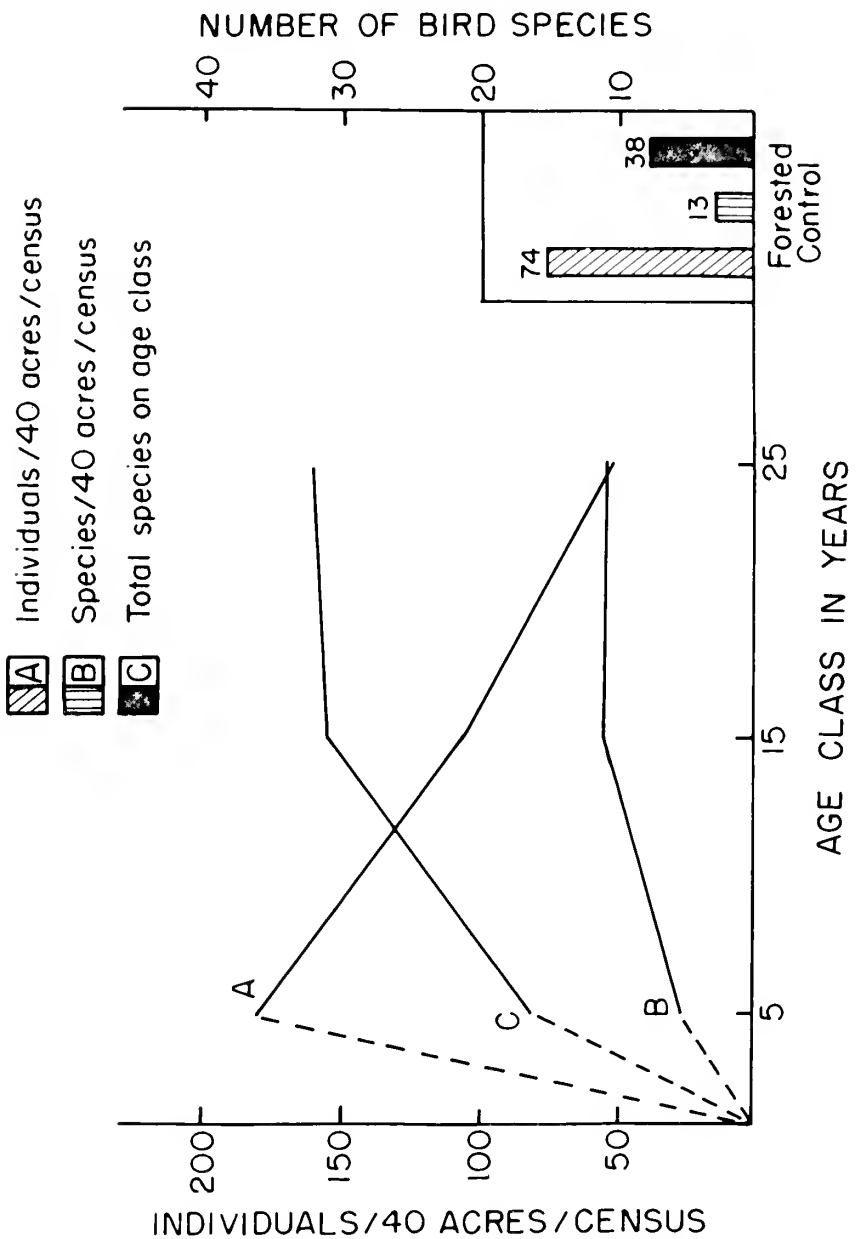

Figure 1. Wintering bird species diversity and abundance patterns on Alabama coal strip-mines, December-January, 1973-74.

Table 2. Wintering bird populations and species diversity related to age of naturally revegetated coal strip-mines in northern Alabama, December - January, 1973-74

Strip-mine (City)	AGE OF MINE SINCE ABANDONMENT							
	Five Years		Fifteen Years		Twenty-five Years		Forested Control	
	Mean Individuals/[a] Species	Total[b] Species	Mean Individuals/[a] Species	Total[b] Species	Mean Individuals/[a] Species	Total[b] Species	Mean Individuals/[a] Species	Total[b] Species
Sunlight (Jasper)	119/10.7	16	110/17	23	82/17	26	68/10.1	25
Kellerman (Tuscaloosa)	399/5	7	122/10.7	16	45/10.7	18	107/15.5	31
Piper (Blocton)	23/0.7	2	83/4.7	7	25/4.3	10	47/14.3	24
Mean/40 acres/Day	180/5.5		105/18.0		51/10.3		74/13.3	
Total No. Species		16		31		32		38[c]

[a]Designates the mean number of individuals and species per 40 acres per census.

[b]Designates the total number of species encountered within the age class during all censuses on all mines.

[c]42 species were encountered on the total spectrum of strip-mines.

in comparison with 38 in Alabama; and eight species in the grass-weed stage contrasted with 16 to 31 in comparable vegetation on the strip-mines.) However, a reversal of this pattern occurred in relation to bare ground situations, on which Quay found 15 species of wintering birds. Although we did not census any new strip-mines that would correspond to that habitat category, our subjective impression was that such new mines were quite species-impoverished. Overall, bird diversity patterns on the strip-mines and adjacent areas more closely resembled that of breeding birds on the Georgia Pidemont (Johnston and Odum 1956) than that of wintering birds in North Carolina. However, diversity was much greater in the Alabama wintering populations than in the Georgia summer fauna (Figure 2).

We found our winter bird species abundance to not differ greatly in this case from breeding birds on strip-mines in Illinois (Brewer 1958, Karr 1968) and Ohio (Smith 1964) (see Figure 2). The one notable difference was that Karr found only 60% as many species in a virgin hardwood forest as he did on 41 to 66-year old strip-mines; whereas, mature forest in Alabama appeared to contain a somewhat greater number of species than the older mines. The oldest mines surveyed in Alabama were considerably younger than those for Illinois. It is doubtful whether the more rapid plant succession of the South would make up this large difference in time.

Great variability existed in bird species numbers between mines of the same age class, with this variability ameliorating over time. For example, species numbers varied significantly ($P < 0.10$ to $P < 0.05$) between all three 5-year old mines, and only 1 paired test involving the 25-year old spoils. In contrast, no differences between the three study areas control plots were detectable from paired comparisons. The largest chi-square calculated for the latter tests was only 0.89. Thus, birds of the second-growth forests were quite tolerant in their habitat tastes, for a very noticeable difference in forest composition occurred between the study areas.

Similarity in species composition between areas was calculated by: $2W/(a + b) \times 100$, where W was the number of species the two censused areas had in common, and $(a + b)$ was the sum of the number of species in each of the 2 areas (Tramer 1974). Data came from Table 3. The percentage thus derived can be used to delineate the degree of similarity between habitats, as well as how catholic were prevailing bird descriminatory preferences.

The 5-year old mines' composition similarity index with the 15 and 25-year old mines, and the forested controls was 55.3, 33.3, and 37.3%, respectively. The 15-year old mines held 73% in common with the 25-year old mine, and 88.1% with the control plots. The 25-year old mine's similarity to the control groups was 90%. Essentially, this indicates that bird population composition on Alabama strip-mines in the region studied had reached near normality after 15 to 25 years. However, if one makes comparisons based upon the more important species (i.e., species with an individual density of 1 or more per 40 acres) a somewhat longer time period of adjustment is necessary. In this case, the similarity between the controls and the 5, 15, and 25-year old mines was 24, 53, and 80%, respectively. Projection of the 80% indicates that total normality

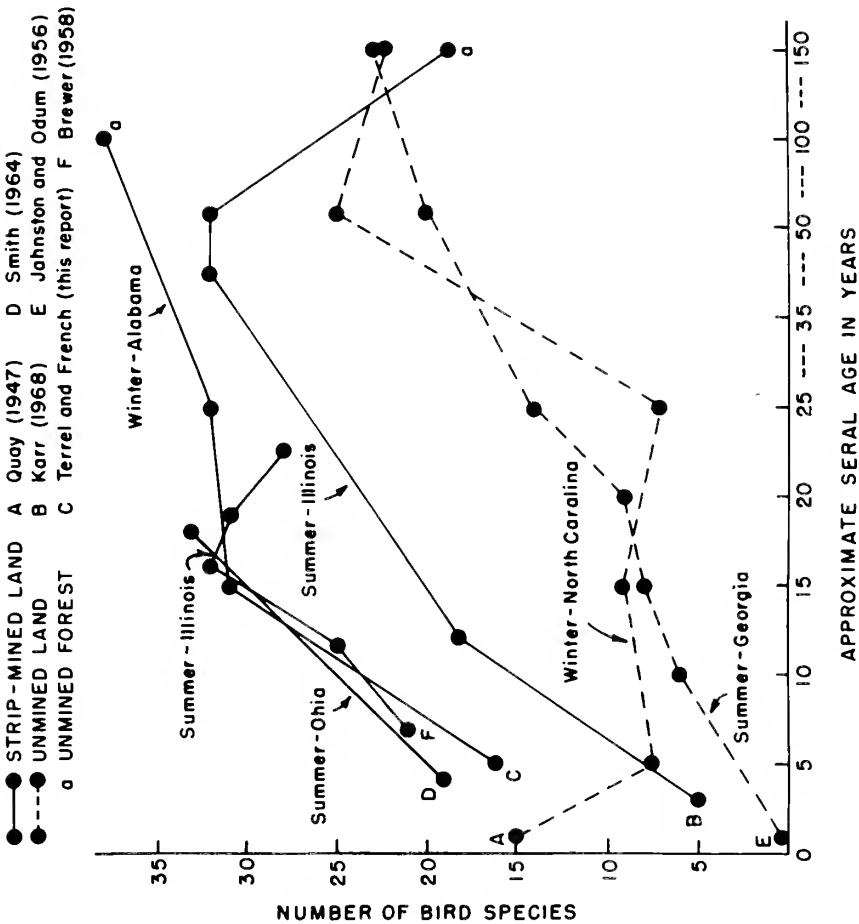

Figure 2. Bird species diversity patterns as related to seral stages on disturbed lands in eastern U.S.A.

Table 3. Wintering bird populations as related to naturally revegetated strip-mines in Alabama, December - January, 1973-74.

Species[b]	Years since mined 5a	15a	25a	Unmined forest
Hooded Merganser *(Lophodytes cucullatus)*			0.1	
Duck (U.I.D.)		0.1		
Sharp-shinner Hawk *(Accipter striaturs)*	0.1			
Red-shouldered Hawk *(Buteo lineatus)*			0.1	0.1
Bobwhite *(Colinus virginianus)*		6.8	1.6	1.3
Wild Turkey *(Meleagris gallopavo)*				0.1
Mourning Dove *(Zenaidura macroura)*	25.4	2.5		0.8
Belted Kingfisher *(Megaceryle alcyon)*			0.2	
Common Flicker*(Colaptes auratus)*	0.8	0.4		0.1
Pileated Woodpecker *(Dryocopus pileaturs)*				0.5
Red-bellied Woodpecker *(Centurus carolinus)*			0.2	1.3
Yellow-bellied Sapsucker *(Sphyrapicus varius)*		0.4	0.4	0.4
Downy Woodpecker *(Dendrocopos pubescens)*		0.4	0.7	1.5
Hairy Woodpecker *(Dendrocopos villosus)*				0.1
Eastern Phoebe *(Sayornis phoebe)*	0.2	0.2	0.2	0.1
Blue Jay *(Cyanocitta cristata)*			1.0	1.8
Common Crow *(Coryus brachyrhynchos)*			0.4	0.1
Carolina Chickadee *(Parus carolinensis)*		4.8	4.8	7.3
Tufted Titmouse *(Parus bicolor)*		0.4	1.0	2.8
Red-breasted Nuthatch *(Sitta canadensis)*				0.1
Brown-headed Nuthatch *(Sitta pusilla)*		0.1	0.7	0.2
Brown Creeper *(Certhia familiaris)*			0.2	0.9
House Wren *(Troglodytes aedon)*			0.2	
Winter Wren *(Troglodytes brunneicollis)*		0.1	0.3	0.3
Carolina Wren *(Thryothrous ludovicianus)*	0.1	0.8	2.9	2.0
Mockingbird *(Mimus polyglottos)*	0.7	1.6		
Brown Thrasher *(Toxostoma rufum)*		0.6		0.1
American Robin *(Turdus migratorius)*		0.9	4.1	0.5
Hermit Thrush *(Hylocichla guttata)*		0.6	1.2	1.1
Eastern Bluebird *(Sialia sialis)*	10.3	1.2		
Golden-crowned Kinglet *(Regulus satrapa)*		6.7	10.4	11.1
Ruby-crowned Kinglet *(Regulus calendula)*		7.9	4.2	5.0
Kinglet (U.I.D.)		0.5	1.3	2.3
Cedar Waxwing *(Bombycilla cedrorum)*	2.3			
Solitary Virio *(Vireo solitarius)*			0.1	tr
Yellow-rumped Warbler *(Dendroica coronata)*	0.8	3.6	2.5	0.9
Pine Warbler *(Dendroica pinus)*		1.1	1.4	2.3
Red-winged Blackbird *(Agelaius phoeniceus)*				tr
Cardinal *(Richmondena cardinalis)*	2.3	7.7	2.7	1.9
Purple Finch *(Carpodacus purpureus)*		0.7		6.3
Gold Finch *(Spinus tristis)*	6.2	0.7	0.6	0.2
Rufous-sided Towhee *(Pipilo erythrophthalmus)*		0.8	0.6	1.6
Vesper Sparrow *(Pooecetes gramineus)*				0.1
Dark-eyed Junco *(Junco hyemalis)*	86.6	35.0	2.7	12.6

Table 3. Continued

Species[b]	Years since mined 5a	15a	25a	Unmined forest
Field Sparrow *(Spizella pusilla)*	86.6	35.0	2.7	12.6
White-throated Sparrow *(Zonotrichia albicollis)*	13.4	7.1	2.5	4.7
Fox Sparrow *(Passerella iliaca)*		0.2	0.7	0.9
Swamp Sparrow *(Melospiza georgiana)*	17.9	4.0	0.1	
U.I.D. birds	0.7	0.3	0.2	0.2
Mean individuals/4-Acres/Day	180.3	105.0	50.8	73.5
Mean Number of Species/40A./Day	5.5	10.8	10.3	13.3
Total Number os Species Observed on Area	16.0	31.0	32.0	38.0

[a]Each column represents number of birds observed per day on 40-acre plots.

[b]Species observed in the vicinity but not on a study plot were: Canada Goose *(Branta canadensis)*, Wood Duck *(Aix sponsa)*, Turkey Vulture *(Cathartes aura)*, Red-tailed Hawk *(Buteo jamaicensis)*, American Kestrel *(Falco sparverius)*, Barred Owl *(Strix varia)*, Great Horned Owl *(Bubo vulgaris)*, Common Grackle *(Quiscalus quiscula)*, Brown-headed Cowbird *(Molothrus ater)* (American Ornithologist's Union 1957).

of bird population composition on a formerly forested strip-mined area would be achieved by approximately 35 years.

Population Density

Bird density patterns, in relation to strip-mine age, ran counter to bird diversity on mines 5 years or older (see Figure 1). Total density was highest on the 5-year old mines and decreased thereafter for at least 20 years ($P < 0.05$). This was also the pattern described by Quay (1947) for the wintering populations on natural seral habitats in North Carolina. With one following exception (Quay's deciduous forest type), the 2 sets of data are quite similar in form. Significantly greater ($P < 0.05$) density occurred on our forested controls than on our 25-year old mines, whereas Quay found that density decreased on similar seral stages.

This pattern of decreasing winter population density with seral time is opposite the norm established in eastern United States for breeding populations on both strip-mines and unmined land (Figure 3). However, Brewer's (1958) strip-mines reached their greatest bird density between 14 and 17 years after abandonment, fitting neither of the above situations.

It is worth pointing out at this point that breeding birds of the Georgia Piedmont (Johnston and Odum 1956) exhibited densities comparable to those of wintering birds on Alabama coal strip-mines. These densities were significantly smaller than those reported for breeding birds on northern strip-mines (Karr 1968, Smith 1964) and wintering populations in the North Carolina uplands (Quay 1947). These studies reported similar density figures for the various seral ages. Consequently, one can infer that the north-central Alabama region has a relatively low bird carrying capacity. However, this region appears to be on parity with the northern sites regarding overall diversity (see Figure 2).

Two important game species (*Colinus virginianus* and *Zenaidura macroura*) were among the predominant species (from a biomass standpoint) on our study areas. A third was *Junco hyemalis*. Competition between the two seed-eating game species was apparently minimized through time demensions. Most doves occurred on the very young mines represented by the 5-year old group, while quail achieved their highest status on the 15-year old. Neither species was well represented in the older seral stages (see Table 3). The average quail density of one per 6 acres, on the 15-year old mines lies between that commonly found on managed and unmanaged (1 quail per 3 and 10 acres, respectively) shrub-grass communities in the South (Speake 1966).

In conclusion, coal strip-mines in Alabama are productive bird habitat during the winter when compared with second growth forests (which comprise 90 percent of the habitat in the coal region of the state) and comparable seral stages from other southeastern areas. The younger strip-mine spoils carried higher bird density than the surrounding forests. However, these dense populations were comprised of only one-half the number of species found in the latter. A balance between diversity and density was achieved on the 15-year old mines. Seral habitat balance of the region combined with the lack of faunal composition similarity between the younger mines and the forested controls indicate that the strip-mine spoils in the

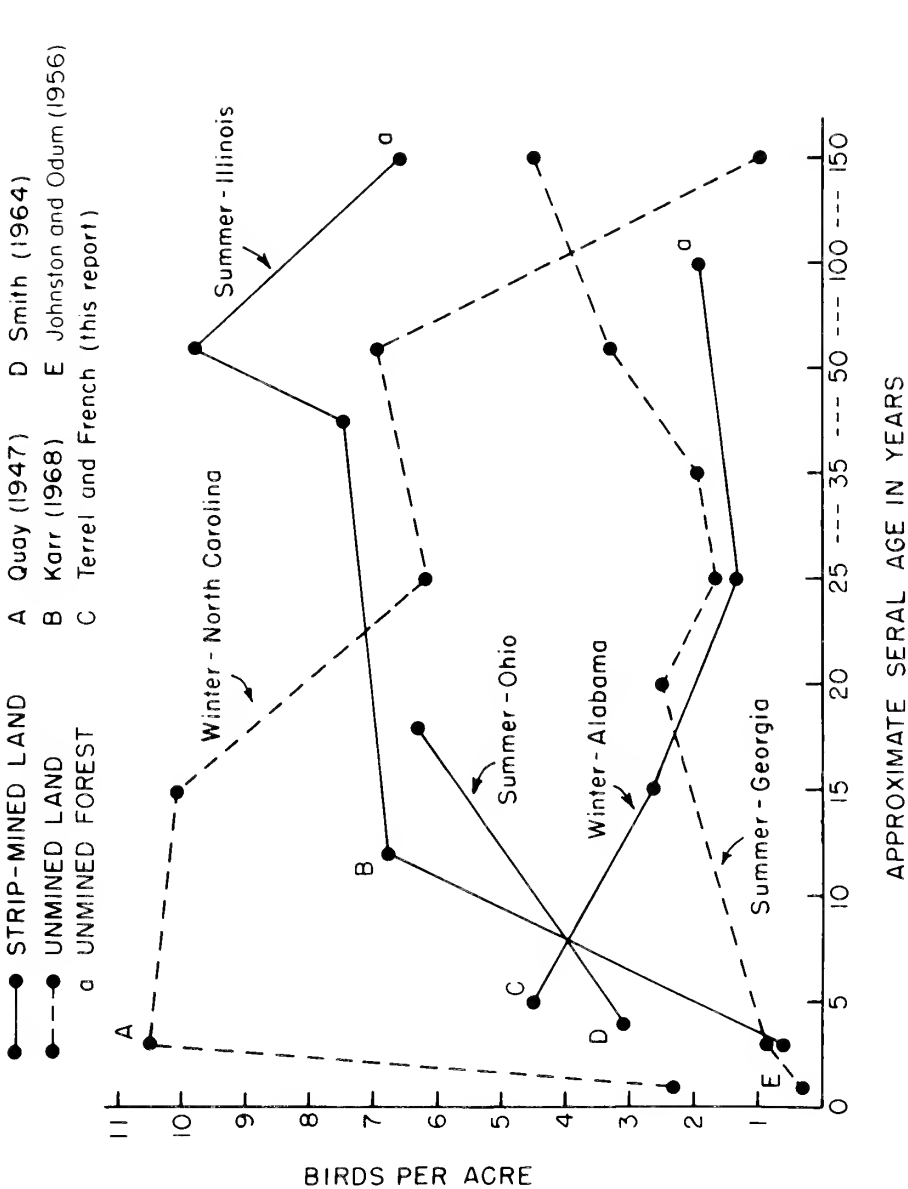

Figure 3. Bird density patterns as related to seral stages on disturbed lands in eastern U.S.A.

particular localities studied were important habitats for birds of low-sere niches.

SUMMARY

Bird populations were censused in December and January, 1973-74, on naturally revegetated, coal strip-mines of varied ages and adjacent unmined forests in north-central Alabama. Each mine age class contained three replicates and 3 censuses were made on each. Censuses were similarly conducted on the seven unmined control plots. Plot sizes ranged from 10 to 40 acres with 10 of the 16 units being 40 acres. Counts were made along parallel compass lines spaced at 165-ft. intervals until each plot was totally censused.

Population diversity and density followed opposing developmental patterns in relation to increasing age of strip-mine spoils. Bird density per 40 acres decreased as mine spoils aged, while bird species numbers increased. Comparative data for density on 5, 15, and 25-year old strip-mines, and the control plots were 180, 105, 51, and 74, respectively. Comparative data for total species on the above treatments were 16, 31, 32, and 38, respectively. Nearly normal species composition, in relation to second growth forests of the area, was reached 25 to 35 years after stripping occurred. However, great variability between mines existed. Bird successional patterns appeared to be within the norms established for natural seres elsewhere in the outheast.

ACKNOWLEDGMENTS

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OBSERVATIONS ON CONSTRUCTION ACTIVITIES OF BEAVER IN EAST-CENTRAL ALABAMA

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ABSTRACT

Four beaver (*Castor canadensis* Kuhl)-colonized areas located in the east-central Alabama area were observed during the period of January, 1972 through January, 1974, in an attempt to determine when and where beaver were most active in building and maintaining dams. Activity occurred all year with major maintenance and building centered around ponds in which occupied lodges or bank dens were present. Data were also gathered concerning the types of building materials used in dam construction. Major building materials consisted of mud and de-barked tree trunks and limbs (cuttings). Lesser amounts of 37 herbaceous and woody plants were also used.

INTRODUCTION

The beaver is a common mammal throughout much of North America and is noted for its creation of dams along small streams. Such beaver-colonized areas typically contain ponds of varying sizes, ages, and depths, only some of which contain actively occupied lodges or bank dens. Dam building and creation of ponds serve to provide protection from land predators, as well as to provide a means of transporting and storing food.

Few studies have been conducted which were specifically concerned with determining the periods of the year in which beaver are most active in building, maintaining, and altering the dams, lodges, and other features of the bottomland ecosystems in which they live. Many reports (Morgan 1868, Townsend 1953, Cahalane 1961, Wilkinson 1962, Longley and Moyle 1963) indicate or infer that the late summer through early fall period is the time of maximum construction activity. These reports, however, appear to be based mainly on general impressions gathered by observation of beaver-colonized areas over a period of time and not on data gathered through systematic study. In addition, these reports usually fail to indicate in which ponds within a colonized are a construction activity is greatest.

This study attempted to systematically examine the activities of 4 beaver colonies located in the east-central Alabama area during the years 1972, 1973, and early 1974, in an attempt to determine when and where major construction activities and habitat alteration occur and to discover what materials were most important as construction materials.

MATERIALS AND METHODS

The study areas (Fig. 1) were located in east-central Alabama in Lee and Macon Counties. Two of the areas (Roxana and Beauregard) lie in the Piedmont Physiographic region while the remaining two (Chewacla and Tuskegee) lie in the Coastal Plain.

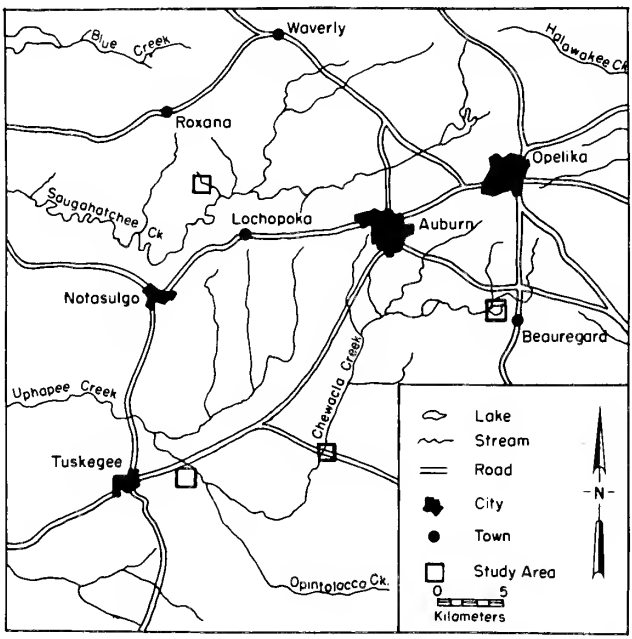

Fig. 1. Map showing location of study areas in east-central Alabama

The Roxana area is located northwest of Auburn along a tributary of Saugahatchee Creek. This tributary is a small woodland stream averaging about two meters in width, which flows in a southeasterly direction and drains a very hilly area of mixed upland forest dominated by species of oak (*Quercus* spp.), hickory (*Carya* spp.) and pine (*Pinus* spp.). Streamflow variation during the year is large and flow is greatest during the winter and lowest in late summer. During periods of heavy rainfall the stream sometimes overflows its banks. Beaver have colonized a segment of this stream about 0.7 km in length and at the termination of this study, 9 ponds were located within the study area. The area is relatively remote and was not appreciably disturbed by human activities during the study.

The Beauregard area is located southeast of Auburn. It contains two man-made lakes which are interconnected by two small beaver ponds. The uppermost lake (Davis Lake) is spring fed and water flow from this

lake into the beaver ponds is constant except during periods of heavy rainfall. The land to the northwest is hilly and forested with oak, hickory, and pine while the land to the southeast is largely gently rolling farmland which is regularly planted. Human activity around this colony was common throughout the study.

The Chewacla area is located east of Tuskegee along U.S. Highway 80. Beaver have created a pond in a large (12 meters wide) roadside ditch and in the adjacent lowlands. The area is located in the Chewacla Creek floodplain and is very flat, swampy, and heavily forested with such species as water oak (*Quercus nigra* L.), maple (*Acer* spp.), sweetgum (*Liquidambar styraciflua* L.), willow (*Salix nigra* Marshall), and buttonbush (*Cephalanthus occidentalis* L.). No permanent stream drains the area. Water is supplied primarily by bottomland seepage which eventually flows northwesterly into Chewacla Creek. During the late summer months, no water flow occurs at all except when heavy rainfall occurs on the area. Little human activity affects the area.

The Tuskegee area is located about 2.5 km east of Tuskegee within the Tuskegee National Forest. Beaver have colonized an area along a small northward-flowing semi-permanent stream, averaging about one meter in width, which is a tributary to Uphapee Creek. One large pond and several smaller ones surrounding the main impoundment have been created. The terrain is flat and the area contains bottomland hardwood forests to the south that are similar to the ones at the Chewacla study area. A pine plantation lies to the north and open fields to the east and west. Streamflow is variable, and in late summer might almost cease. The large pond is heavily used by local people for fishing and, therefore, human activity on the area is great.

Most information gathered was obtained from two sources: (1) measurement of water level fluctuation in selected beaver ponds, and (2) direct observation of evidence of beaver activity in and around ponds.

Changes in water level were used as an index of dam building activity, and it was assumed that poorly maintained dams would allow water levels to decrease unless such a decrease was due to other observed factors such as a lack of sufficient water inflow to maintain a full pond. Conversely, increasing water levels were assumed to be due to raising dam height, unless such increases were obviously due to recent rainfall.

Water level changes were measured by use of permanently installed steel marker posts placed in selected ponds. The initial water level was used as a zero point and deviation above or below the initial point was measured at intervals of from one to several weeks throughout the study. Measurements were avoided during, and for 24 to 48 hours following, periods of heavy rainfall, and thus should not have been biased due to floodwaters.

Throughout this study, a representative collection of material used in dam building was made and identified and the types of materials used during different times of the year were recorded. Collections and notations were made by walking along the dams and gathering samples of all

recognizable material that had recently been added to the dams. Materials not immediately identified were preserved as herbarium specimens.

RESULTS AND DISCUSSION

Water level changes were recorded for a 2-year period in 12 ponds (copies of these data are available from the author). These changes varied greatly from pond to pond and in some cases from time to time within an individual pond. Water levels in two ponds remained essentially unchanged throughout the study period. Water levels in two other ponds were also relatively constant except during July, August, and September 1972 when water levels fell drastically due to a break in a dam which was subsequently repaired. In four ponds, water levels at the end of the study period were considerably lower than at the beginning and had been lower for most of the study period. In the remaining ponds, water levels fluctuated through the study period. Maximum increase in water level above the initial point was 33 cm and occurred in the Tuskegee area. Maximum decrease was 110 cm and also occurred in the Tuskegee area. Ranges of fluctuation within individual ponds varied from a low of 22 cm to a high of 120 cm. No definte yearly patterns of high and low water levels attributable to beaver activity could be seen which would consistently apply to all the ponds examined. High water levels often occurred during all months except June, July, and August.

It appears that Wilkinson's (1962) report concerning the season of maximum beaver construction activity in east-central Alabama did not invariably hold true in this study. Beaver showed no well-defined season of maximum activity and the amount of activity associated with a given pond varied greatly. Observations on water level fluctuation and presence of recent beaver sign indicated that beaver were active throughout the year in maintaining dams of ponds in which an occupied lodge or bank den was found. This finding was further supported by observations on the Beauregard area which showed that one dam was kept in good repair only during the period of January, 1973 to January, 1974, when beaver reoccupied a formerly abandoned lodge in that pond.

Maintenance was sporadic in ponds lacking lodges or bank dens and on several occasions the ponds went nearly dry even though water flowing into them was adequate to keep them full had they been in good repair.

Water levels in some ponds seemed to be directly related to the weather and to periods of low rainfall. This was seen in both the Chewacla and Tuskegee areas as ponds in both places had very low water levels in late summer at a time when rainfall and runoff was scarce. Beaver activity during this same period was quite high, however, and much work was done to retain what little water was present.

Some evidence that beaver do tend to become more active in fall was seen in the Beauregard area where in both 1972 and 1973 major attempts were made during September, October, and November to dam the spillway outlet to Davis Lake. As mentioned previously, water flow through the spillway remained constant the year around and beaver made few attempts to build a dam here except during these months.

Building materials used during the 2-year study period are shown in Table 1. Thirty-seven identifiable species of herbaceous and woody plants were utilized. The most commonly used building materials throughout the year were mud and "cuttings" (unidentified small to large tree branches and trunks from which bark had been stripped). Beaver did not show any discernable perferences for one type of vegetation over another and apparently made use of whatever building material was on hand and was readily available.

Table 1. Materials used in dam building by four east Alabama beaver colonies during the period January, 1972 through January, 1974.

Mud
Cuttings[a]
Green Algae (*Spirogyra* sp.)
Muskgrass (*Chara* sp.)
Parrot Feather (*Myriophyllum brasiliense* Cambess)
Soft Rush (*Juncus effusus* L.)
Red Rooted Sedge (*Cyperus erythrorhizos* Muhl.)
False Loosestrife (*Ludwegia natans* Ell.)
Touch-me-not (*Impatiens pallida* Nuttall)
Smartweed (*Polygonum* sp.)
Aster (*Aster pilosus* Willd.)
Cutgrass (*Leersia oryzoides* (L.) Swartz.)
Cattail (*Typha* sp.)
Pondweed (*Potomogeton* sp.)
Japanese Honeysuckle (*Lonicera japonica* Thunberg)
Yellow Water Lily (*Nuphar advena* Ait.)
Bladderwort (*Utricularia* sp.)
Blackberry (*Rubus* sp.)
Black Willow (*Salix nigra* Marshall)
Alder (*Alnus serrulata* (Aiton) Willd.)
Wax Myrtle (*Myrica cerifera* L.)
Red Maple (*Acer rubrum* L.)
Chalk Maple (*A. leucoderme* (Small) Desmarais)
White Oak (*Quercus alba* L.)
Water Oak (*Q. nigra* L.)
Switchcane (*Arundinaria gigantea* (Walter) Muhl.)
Flowering Dogwood (*Cornus florida* L.)
Swamp Dogwood (*C. stricta* Lam.)
Ash (*Fraxinus* sp.)
Buckeye (*Aesculus* sp.)
Hop Hornbeam (*Ostrya virginiana* (Miller) K. Koch.)
Elderberry (*Sambucus canadensis* L.)
Tuliptree (*Liriodendron tulipifera* L.)
Elm (*Ulmus* sp.)
Swamp Privet (*Foresteria acuminata* (Michaux) Poiret)
Sweetgum (*Liquidambar styraciflua* L.)
Buttonbush (*Cephalanthus occidentalis* L.)

Table 1. Continued.

Titi (*Cyrilla racemiflora* L.)
River Birch (*Betula nigra* L.)

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[a]Unidentified small to large tree branches and trunks from which bark had been stripped.

CONCLUSION

It is concluded that the seasonal variation in construction activities exhibited by east-central Alabama beaver is not great, but that a slight peak of activity is shown in the Fall. Furthermore, construction activity is most intense in ponds containing an occupied lodge or bank den and in such ponds construction activity is carried on all year long.

ACKNOWLEDGMENTS

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THE CHANGING STRUCTURE OF COMMERCIAL BANKING IN ALABAMA

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One of the most significant developments in Alabama's economy in recent years has been the dramatic change in the structure of commercial banking. Since no two states view banking supervision the same, particularly in the area of expansion of banking facilities, the evolution of the banking structure in various states has varied widely.[1] This study seeks to examine the trend of Alabama banking since 1946--especially its structure which includes the number of banks, their relative size, the number of banking offices, and the holding company movement--and to attempt to discern the general direction of change for the rest of the decade.

Early Development

The growth in the number of banks and their resources have closely followed the pace and intensity of economic development in the state. As late as 1880 the state had only 39 banks with total resources of $5,036,764.[2] By 1900 the state was served by 107 banks and at the end of 1919 the number of banks reached a peak of 358, with total resources of $235 million. Total banking resources reached a high of $377 million in 1929. Widespread bank failures in the 1920's reduced the number of banks in the state to only 203 with total resources of $235 million at the end of 1933. The number of banks in the state grew gradually following 1933 and at the end of 1946 numbered only 219. During the late forties and throughout the fifties the number of new banks continued to increase, reaching a total of 238 in 1960. The tempo of growth accelerated during the sixties and early seventies and at the end of 1973 there were 287 banks in Alabama with aggregate resources of $8.6 billion.[3]

Growth Since 1946

Table 1 shows the steady growth in banking in Alabama since World War II. It notes that total banking resources increased from $1,298,686,000 at the end of 1946 to $2.35 billion at the end of 1960. This represents an 81 per cent increase compared to a gain for the nation as a whole of

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[1]Douglas V. Austin and Thomas L. Stevens, "Ohio Banking Structure's New Look," *Akron Business and Economic Review*, Vol. No. 3, Fall 1971, p. 28.

[2]William W. Cox, *The Development of Banking in Alabama* (unpublished thesis) Stanier Graduate School of Banking, Rutgers University, 1950, p. 13.

[3]U. S. Federal Deposit Insurance Corporation, Annual Report, 1973 and the *Federal Reserve Bulletin*, February 1974, p. A99.

TABLE I

THE STRUCTURE OF COMMERCIAL BANKING
COMPARATIVE STATEMENT OF CONDITIONS OF ALL INSURED COMMERCIAL BANKS
IN ALABAMA* DECEMBER 31, 1946, DECEMBER 31, 1960, AND DECEMBER 31, 1973**
(Amounts in Thousands of Dollars)

	Amount	Per Cent	Amount	Per Cent	Amount	Per Cent
ASSETS	1946		1960		1973	
Cash and balances with other banks	346,190	26.66	483,760	20.58	1,061,299	12.33
U. S. Government securities	580,597	44.70	590,509	25.13	716,445	8.32
Other securities	99,275	7.64	252,586	10.75	1,797,635	20.88
Loans and discounts	260,427	20.05	985,067	41.91	4,492,536	52.18
Bank premises, furniture and fixtures	8,773	.68	31,235	1.33	164,444	1.92
Miscellaneous assets	3,424	.27	7,115	.30	376,423	4.37
Total Assets	1,298,686	100.00	2,350,272	100.00	8,608,782	100.00
LIABILITIES						
Demand deposits	975,165	75.08	1,507,053	64.12	3,370,948	39.15
Time deposits	248,323	19.12	613,666	26.01	4,060,336	47.16
Miscellaneous liabilities	5,542	.43	33,420	1.40	513,709	5.96
Total liabilities	1,229,030	94.63	2,154,139	91.53	7,944,993	92.27
CAPITAL ACCOUNTS						
Capital notes and debentures	--	--	--	--	4,300	.05
Capital stock	24,271	1.87	58,425	2.04	160,809	1.88
Surplus	28,344	2.18	83,830	2.90	249,964	2.90
Undivided profits	12,588	.97	44,880	3.50	238,131	2.78
Reserves	4,453	.35	8,998	.03	10,585	.12
Total capital accounts	69,656	5.37	196,133	8.47	663,789	7.73
Total liabilities and capital accounts	1,298,686	100.00	2,350,272	100.00	8,608,782	100.00

* In 1946 there were three noninsured banks with resources of approximately 2.3 million dollars. All banks in the state have held membership in the Federal Deposit Insurance Corporation since 1960. (See FDIC Annual Report for 1946 and 1960.)

** 1973 year-end dates projected on the basis of growth reported by F.D.I.C. in first six months of 1973.

Source: U.S. Federal Deposit Insurance Corporation, Report of Call: Assets, Liabilities, and Capital Accounts, Commercial and Mutual Savings Banks, No. 26, December 31, 1946 and No. 54, December 31, 1960, and Assets, Liabilities, Commercial and Mutual Savings Banks, June 30, 1973.

only 72 per cent during the same period. However, when Alabama's much lower starting base is considered, the absolute rate of change in the state's banking resources was only slightly more rapid than for the nation as a whole during the period. From the end of 1960 to the end of 1973 the state's banking resources grew from $2.35 billion to $8.61 billion, a gain of 224 per cent compared with the national increase of 171 per cent for the period. Alabama banks held .767 per cent of the nation's total banking resources at the end of 1946 and by the end of 1973 this figure had increased to 1.06 per cent of the national total. During this period the per capita income in Alabama increased by 149 per cent, while the per capita income for the nation increased by only 121 per cent.[4]

Sharp changes in the uses and sources of banking resources in Alabama since 1946 is also shown in Table I. Since the close of World War II, the most pronounced change in the use of bank funds in the state has been the sharply increased percentage of total resources represented by loans and the substantial reduction in the percentage of funds represented by cash and U. S. Government securities. In 1946 loans accounted for only 20 per cent of Alabama's banking resources, but by the end of 1960 loans increased to 41.91 per cent of banking resources. Loans increased further to 52.18 per cent of resources by the end of 1973.

The percentage of funds held as cash declined from 26.66 per cent to 20.58 per cent at the end of 1960 and declined even more sharply between 1960 and 1973 to only 12.33 per cent of bank resources. Investments in U. S. Government securities were reduced from 44.7 per cent of total banking resources at the end of 1946 to 25.13 in 1960 and to only 8.32 per cent in 1973. Changes in the use of bank funds as reflected in the heavy demand for bank loans and the purchase of municipal bonds since 1946 can be attributed to the strong economic growth in Alabama in the post-war period.

The strong shift in the source of funds since 1946 has been in the greater percentage of funds provided by time deposits with a corresponding decline in demand deposits. Time deposits represented only 19 per cent of total assets in 1946 but had increased to 47.16 per cent at the end of 1973. Demand deposits equaled 75.08 per cent of total resources in 1946, but had declined to only 39.15 per cent of banking resources at the end of 1973. The greatest part of the shift from demand to time deposits has been since 1960 as is indicated in Table I. This can be explained largely by the sharp upward trend of short term interest rates during the period.

INCREASE IN BANKING OFFICES SINCE 1946

A strong rate of growth in the number of banks in Alabama has been recorded since the close of World War II. From a total of 219 banks serving the state in 1946, the number had increased to 277 by the end of 1972 as indicated in Table II which gives a summary of the growth in the

[4]Ibid.

TABLE II

CHANGES IN THE NUMBER AND TYPES OF BANKS
OR BANK OFFICES IN ALABAMA
1946-1972

Type of bank or office	1946	1950	1955	1960	1963	1972
Total Bank Offices	242	251	284	328	371	611
Banks	219	225	237	238	242	277
National	66	70	69	69	73	89
State	150	155	168	169	169	188
Member of Federal Reserve System	19	23	25	24	24	20
Nonmember of Federal Reserve System	131	132	143	145	145	168
Unit Banks	214	219	221	214	207	174
National	62	65	56	51	50	40
State	149	154	165	163	157	134
Banks Operating Branches	5	6	16	24	35	103
National	4	5	13	18	23	49
State	1	1	3	6	12	54
Branches	23	26	47	90	129	334
National	22	25	43	77	105	229
State	1	1	4	13	24	105

Source: U. S. Federal Deposit Insurance Corporation, Annual Report. 1946, 1950, 1955, 1960, 1963, 1972.

number and types of banks or banks' offices during the period 1946-1972. A more recent source reports an additional ten new banks were organized in 1973 to bring the total to 287.[5] This source does not give a breakdown by types of banks and the number of branches.

Table II reveals that the growth of both new banks and branches was rather slow between 1946 and 1950 with an increase of only six banks and three branches in this period. However, between 1950 and 1960 the rate of growth in new banks and branches accelerated, particularly in the establishment of new branches, with the addition of 13 new banks and 64 new branches bringing the total number of banks to 238 and the number of branches to 90.

The rate of increase in new banks and branches was even more rapid in the period 1960-1972. During this period 39 new banks were established but more dramatic was the addition of 244 new branches or an increase of more than 20 a year. Between 1946 and 1960, the number of banks operating branches increased from 5 to 24 and between 1960 and 1972 the rate of growth was even greater growing from 24 to 103. Since 1946 the number of bank offices, banks plus branches, increased from 242 in 1946 to 611 at the end of 1972 or an increase of 150 per cent. The rate of expansion since 1960 has been almost 100 per cent.

While the number of state chartered banks has increased from 150 to 188 since 1946, there has been only one additional state member bank (Federal Reserve System) during the period. The growth in state chartered banks since 1946 has been almost double the number of new national banks and thus the ratio of state to national banks has remained about the same over the period. However, national banks accounted for almost twice as many new branches during the period as did state banks. As indicated earlier, the number of new banks contined to increase at a rapid rate with the 1973 year-end total reaching 287. There is every indication that the rate of growth among branches also continues to expand at a similarly rapid rate. The strong increase in the number of banks and branches since 1946 resulted from several factors: the growth in retail banking, the increased development of shopping centers and the strong overall economic growth in the state.

BRANCH BANKING IN ALABAMA

As clearly shown in Table II most of the recent increase in banking offices in Alabama has come through the growth in branch banking. This is of particular interest when it is pointed out that the *Code of Alabama* does not permit branch banking. A bit of history will explain the state's complicated branching system. Before 1911 Alabama was one of the states which permitted branch banking "merely because the law was silent on the subject."[6]

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[5]Federal Reserve Bulletin, February 1974, p. A99.

[6]Shirley Donald Southworth, *Branch Banking in the United States*, First Edition: McGraw-Hill Book Co., New York, 1928, p. 20.

Despite the fact that branch banking was practiced to a limited extent in Alabama, no reference to branch banking can be found in the Alabama codes prior to 1911.[7] With the passage of "An Act to Create a Banking Department" in 1911, a provision was included that made branch banking unlawful.[8] A grandfather clause in the act protected banks having branches at that time. The only such bank still in operation in 1974 is the Central Bank of Alabama, N. A. with branches in 15 towns located in eleven counties in North Alabama. For twenty-four years branch banking in Alabama was restricted to this bank.

In 1931 two Birmingham neighborhood banks became overextended and both the First National Bank of Birmingham and the Birmingham Trust National Bank made sizable investments in them to provide badly needed capital. Until 1935 these banks were operated as affiliates of the two larger banks, apparently in violation of Alabama's "No Branching Law." However, on January 29, 1935, the Alabama Legislature enacted what is known as a general law with "local applications," which authorized branch banking in Jefferson County.[9] Thus, these two affiliates became branches of the First National Bank of Birmingham.

No additional branching legislation was passed until 1953 when separate acts were approved providing for branch banking in Montgomery, Lauderdale, Calhoun, and Winston counties.[10] Since that year there have been one or more acts extending branch banking to additional counties passed at each session of the legislature. By the end of the 1973 session, when 20 special branching acts were approved, branching privileges had been extended to 51 of the state's counties.

Contrary to what might be assumed, the 90 special acts enacted between 1935 and 1973 providing for branch banks in Alabama counties are far from uniform. Branch banking in Alabama counties falls into the divisions that are usually used in describing branch banking for the nation as a whole; County-wide Branching, Limited Branching and No Branching. Table III gives a breakdown of the extent of branching in the various counties. Nineteen counties have unlimited branching, thirty-two counties have limited branching, either by geographical restriction to a given area of the county or by relating the number of branches to a given amount of capital, and 16 counties still do not permit branching.

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[7] *General Provisions as to Banks and Banking, Code of Alabama* 1907, Article 9, Sections 3518-3527. Also, *Free Banking Corporations, Code of Alabama* 1876, Article VIII, Sections 1944-1990.

[8] *General Laws of the Legislature of Alabama,* Session of 1911, p. 77.

[9] Wallace Davis Malone, Jr., *Commercial Banking in Alabama* 1947-1957, (unpublished Master's Thesis) Wharton School of Business, University of Pennsylvania, 1959. p. 157.

[10] *Acts of Alabama* 1953-1973.

TABLE III
SUMMARY OF BRANCH BANKING LAWS
IN ALABAMA BY COUNTIES
March 1, 1974

County-Wide Branch Banking		Limited Branching Within County		No Branching	
County	Population	County	Population	County	Population
Coosa	10,662	Cleburne	10,996	Greene	10,650
Henry	13,254	Lamar	14,335	Bullock	11,824
Bibb	13,812	Winston	16,654	Clay	12,636
Hale	15,888	Butler	22,007	Lowndes	12,897
Washington	16,241	Barbour	22,543	Crenshaw	13,188
Choctaw	16,589	Marion	23,788	Perry	15,388
Sumter	16,974	Marengo	23,819	Cherokee	15,606
Randolph	18,331	Macon	24,841	Conecuh	15,645
Autauga	24,460	Pike	25,038	Fayette	16,252
Chilton	25,180	Clarke	26,724	Wilcox	16,303
Lawrence	27,281	Blount	26,853	Pickens	20,326
Coffee	34,872	St. Clair	27,956	Monroe	20,883
Limestone	41,699	Elmore	33,535	Geneva	21,924
Russell	45,394	Tallapoosa	33,840	Franklin	23,933
Dallas	55,296	Escambia	34,906	Covington	34,079
Walker	52,246	Shelby	38,037	Chambers	36,356
Baldwin	59,382	Jackson	39,202		
Lee	61,268	Dekalb	41,981		
Mobile	317,308	Colbert	49,632		
		Cullman	52,445	16 Counties	
		Dale	52,938		
		Marshall	54,211		
19 Counties		Houston	56,574		
		Talladega	65,280		
		Lauderdale	68,111		
		Morgan	77,306		
		Etowah	94,144		
		Calhoun	103,092		
		Tuscaloosa	116,029		
		Montgomery	167,790		
		Madison	186,540		
		Jefferson	644,991		
		32 Counties			

Source: *Acts of Alabama* 1935-1973, and *Code of Alabama Recompiled* (1958), Population Tables 1970 Census.

CHANGING SIZE OF ALABAMA BANKS

A comparison of the size of Alabama banks between 1963-1972 is found in Table IV. It is noted that while a large number of Alabama banks would have to be characterized as being small, the number of banks with deposits of less than five million dollars declined from 155 in 1963 to 45 at the end of 1972. The greatest growth came in the number of banks in the 10 to 25 million dollar deposit range, which increased from 18 in 1963 with total deposits of $356 million to 109 in 1972 with total deposits of $1.7 billion. One factor accounting for this is that a number of the 35 new banks chartered during this period fall into this size range. Also, since total deposits in the state more than doubled during the period, it is not surprising that the size groups (2 to 5 and 5 to 10 million dollar deposits) comprising the largest number of banks in 1963 should experience such a large shift of banks to the 10 to 25 million dollar deposit range.

While the number of banks with deposits of over $100 million increased from six to nine, the percentage of total state deposits held by banks in this range actually declined slightly from 43.61 per cent to 42.72 per cent during the period. Concentration of banking resources among the two largest banks in the state declined from 25.33 per cent of the state's bank deposits in 1963 to 18.27 per cent at the end of 1972.

BEGINNING OF MULTI-BANK HOLDING COMPANY MOVEMENT IN ALABAMA

An attempt to merge the State National Bank of Alabama into the Central Bank of Birmingham, a state bank, in 1968 resulted in a suit by William H. Ellis and a group of Alabama banks, charging that the merger would violate the branch banking laws of Alabama. However, the court ruled on the basis of a conflict of laws that a national bank could not be merged into a state bank unless the "law of the state where the national bank is located allows a state bank to merge with a national bank without approval of any state authority."[11] Since Alabama law requires permission of the State Banking Superintendent for a merger, the court ruled that the merger would be invalid. However, before the court handed down its decision, a group of banks headed by the First National Bank of Montgomery, took steps to form the state's first multi-bank holding company--The First Alabama Bancshares, Inc., which received approval of the Federal Reserve Board on April 20, 1971.[12] This was the beginning of multi-bank holding companies in Alabama.

After several abortive attempts to pass a state-wide branching law in the late sixties, the major banks in the state turned to the holding company mechanism as the vehicle for expansion into all parts of the state. Since Alabama law is silent on bank holding companies, the

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[11]Ellis V. State National Bank of Alabama, *et al.*, 434 F2d 1182 (5th Cir. 1970); 402 U. S. 973, 91 S. Ct. 1661 (1971).

[12]*Federal Reserve Bulletin*, May 1971, pp. 404-414.

TABLE IV

ALABAMA COMMERCIAL BANKS
GROUPED ACCORDING TO AMOUNT OF DEPOSITS
December 31, 1963 and December 31, 1972

Deposit Size Millions of Dollars	Numbers of Banks	Total Deposits Thousands of Dollars	Per Cent of State Total	Number of Banks	Total Deposits Thousands of Dollars	Per Cent of State Total
		1963			1972	
Less than 1	14	10,213	.39	1	838	.01
1 to 2	39	60,306	2.39	7	10,390	.15
2 to 5	102	352,516	13.50	37	136,541	2.01
5 to 10	52	356,318	14.43	89	673,790	9.01
10 to 25	18	259,464	9.09	109	1,724,255	25.39
25 to 50	10	360,767	13.80	15	533,933	7.86
50 to 100	1	72,617	2.79	9	661,390	9.74
100 to 200	4	477,332	18.28	2	249,383	3.67
200 to 300	1	231,307	8.84	5	1,225,879	18.05
300 to 400	0	--	--	1	333,228	4.93
400 to 500	1	430,133	16.49	1	435,120	6.40
500 to 900	1	--	--	1	806,123	11.87
Totals	242	2,610,973	100.00	277	6,791,991	100.00

Source: Southern Bankers Directory 1964, 1973; Special Alabama Edition, McFadden's Publications, Norcross, Georgia.

Federal Reserve Board, under the authority assigned to it by the Bank Holding Company Act of 1956, has ruled on eight occasions since 1971 that the establishment of bank holding companies in Alabama would be in the public interest in that they would increase competition between the larger banks in the state.[13]

Rapid development of the eight state-wide bank holding companies as illustrated in Table V has brought about far-reaching changes in the state's banking structure. It is noted that eight holding companies that included 41 banks held $5.2 billion in assets or 60 per cent of the state's banking resources at the end of 1973. When the fifteen additional banks that have received approval for acquisition by holding companies or have announced agreements of intent to become a part of a holding company are considered, holding companies represent 64.30 per cent of Alabama's banking resources. Holding companies control a slightly higher percentage of the state's total bank deposits.

Holding company expansion has recently entered a new phase as most of the larger banks have already joined holding companies. Future expansion will come through the purchase of smaller banks, but more importantly by the entry of new banks into the larger trade areas where there are no eligible banks for purchase.

An analysis of the data in the 1973 *Southern Bank Directory* reveals that 12 Alabama cities control 70 per cent of the state's deposits. These cities are Mobile, Dothan, Montgomery, Selma, Auburn-Opelika, Tuscaloosa, Birmingham, Anniston, Gadsden, Decatur, Huntsville, and Florence-Sheffield-Tuscumbia.

Wallace Malone, Jr., President of the Alabama Financial Group, contends that all bank holding companies, particularly the four big ones, find it "absolutely mandatory that they get into these cities sooner or later... one way or another. The only question is not whether they will move into these cities, but when."[14] He predicts that holding companies will control 80 per cent of Alabama's banking resources by 1980.

A move to reduce the speed of holding company expansion was undertaken by the State Banking Board on October 13, 1973 when it published Regulation 13, which declares that state charters for new banks will not be granted to stockholders who have an interest in a bank holding company.[15] This action followed a denial by the State Banking Board of an application by Central Bancshares to establish new banks in Tuscaloosa and Jasper.[16]

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[13] *Federal Reserve Bulletin*, May 1971, pp. 404-414; Oct. 1971, pp. 862-865; Sept. 1972, pp. 822-824; Nov. 1972, pp. 988-990; Jan. 1973, p. 31; May 1973, p. 542, August 1973, pp. 583-584.

[14] *Birmingham News*, March 22, 1974, p. 10A.

[15] State Banking Board, Regulation No. 13, Oct. 31, 1973.

[16] *Birmingham News*, Jan. 6, 1974, p. 16F.

TABLE V

Multi-Bank Holding Companies in Alabama
December 31, 1973
(Amounts in Thousands of Dollars)

Holding Company	Lead Bank	Number of Banks	Deposits	Assets	% of Total Bank Assets
Alabama Bancorporation[a]	First National Bank of Birmingham	7	$1,175,837	$1,390,880	16.16
First Alabama Bancshares[b]	First National Bank of Montgomery	6	814,904	971,872	11.30
Alabama Financial Group[c]	Birmingham Trust National Bank	7	737,666	947,048	11.01
Central Bancshares[d]	Central Bank of Birmingham	7	779,788	904,967	10.51
Southland Bancorporation	Merchants National Bank of Mobile	3	396,670	434,690	5.05
First Bancgroup-Alabama	First National Bank of Mobile	2	339,356	400,218	4.65
United Alabama Bancshares	City National Bank of Dothan	4	86,582	103,058	1.20
Citibanc Group	Covington County Bank	5	54,000	62,950	.07
		41	$4,594,188	$5,215,686	59.95

[a]Two additional Banks approved and one announced, total assets $72,719,350.

[b]Three additional Banks approved and four announced, total assets $168,154,385.

[c]Two additional Banks approved, total assets $40,665,316.

[d]Two additional Banks approved and one announced, total assets $37,925,529.

Source: Federal Reserve Bank of Atlanta and Alabama Financial Group.

This move by the State Banking Board is not likely to reduce the growth of multi-bank holding companies for very long. It has only caused holding companies for very long. It has only caused holding companies to turn to the Comptroller of the Currency for national charters.[17]

SUMMARY AND CONCLUSIONS

Alabama's restrictive bank branching law which limits branching to a single county has caused the larger banks in the state since 1971 to turn to the holding company form of orgainization to direct entrance into markets throughout the state. While the holding company mechanism does not provide quite the flexibility of state-wide branching, it has resulted in an improved mobilization of the banking resources of the state. This is the principal benefit usually claimed for unlimited branch banking.[18]

The holding company experience in Alabama is too recent to determine if economies of scale have been obtained. Also, it will take time to affect the cetralization of many bank functions. It is clear, however, that some smaller communities are already experiencing full banking services from their local banks for the first time. In the past many banking services were only available through the use of correspondent banks.

Given the momentum of the recent movement toward a reduction in the number of unit banks in Alabama, the number of banks owned by multi-bank holding companies are likely to continue to expand despite the State Banking Department's apparent effort to slow down this growth. This has been the trend in other states that have a longer experience with bank holding companies. Barring any major change in the attitude of federal regulatory agencies, the percentage of Alabama banking resources held by multi-bank holding companies is likely to continue to increase, although at a reduced rate, over the remaining years of the current decade. Thus, Alabama's economy should be strengthened by a more efficient utilization of banking resources and a higher quality of banking services throughout the state.

Some observers may express concern about the control of an increasing percentage of Alabama's banking resources in the hands of a few large multi-bank holding companies. However, the more rapid economic development of North Carolina and Florida in recent years where either well developed statewide branching or holding company systems prevail should dispel these fears.

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[17]Interview with John Hendrix, Jr., Corporate Secretary-Assistant Treasurer, Central Bancshares of the South, Inc., April 2, 1974.

[18]"The New Look in Banking Structure," Monthly Review, The Federal Reserve Bank of Richmond, July 1963, pp. 4-5.

AGE AND GROWTH OF CHANNEL CATFISH IN THE ALABAMA AND TOMBIGBEE RIVER DRAINAGES, ALABAMA

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ABSTRACT

Age and growth of channel catfish were compared between six sampling areas in the Alabama and Tombigbee River drainages of Alabama during 1969 and 1970. The body-spine relationships for channel catfish were computed by regression analyses ($Y = a + bX$) for each area, each year, and showed high correlation ($r > 0.80$). Variance analyses of back-calculated length at each annulus revealed that significant differences ($P = 0.001$) existed between areas. Comparison of growth curves supported the trend of fastest growth in the Alabama River, intermediate growth in Lake Martin and in the Warrior River, and slowest growth in the Tombigbee River and Lake Jordan. Factors which influenced apparent growth differences are discussed.

INTRODUCTION

Previous Work

An extensive sport and commercial fishery exists for channel catfish in the Alabama and Tombigbee River drainages, yet no basic information is available on age and growth of this species in these areas. The rivers traverse several physiographic provinces (Fenneman, 1938) which yield variable mineral content and other aspects of water quality. Movement of the channel catfish populations has been restricted to some extent by locks and dams, which provide an opportunity to compare growth of this species in areas of differing environmental factors.

Carlander (1969) has reviewed the literature on the biology of this species. Numerous studies have been carried out on age and growth of channel catfish, particularly in Oklahoma. Finnel and Jenkins (1954) compiled data from prior surveys in that state. They compared growth under various environmental conditions, analysing such factors as new and old waters, clear and turbid waters, lakes with and without apparent reproduction, and in ponds, small lakes, large lakes, reservoirs and streams. They reported that channel catfish grew faster in small impoundments than in any other size category. The slowest growth was in old reservoirs and in large lakes. Growth rates were much greater in waters impounded for less than four years. The majority of slowly growing catfish populations were found in turbid waters with high populations. They further stated that other environmental factors, including age of water body, turbidity, and extent of successful reproduction appeared to influence the rate of growth more than area inhabited.

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Age and Growth of Channel Catfish

Purpose of Study

The purpose of this two-year study was to obtain age and growth data on channel catfish in the Alabama and Tombigbee River drainages of Alabama and to determine the influence of artificial barriers, water quality, and pollution on growth.

Acknowledgments

This research was supported by the Alabama Cooperative Fishery Unit in cooperation with the U.S. Fish and Wildlife Service, Auburn University, and the Game and Fish Division, Alabama Department of Conservation and Natural Resources. It is based on part of a dissertation submitted to the Graduate Faculty, Department of Fisheries and Allied Aquacultures, Auburn University, in partial fulfillment of the requirements for the degree of Doctor of Philosophy, December 1971.

Appreciation is extended to Drs. William D. Davies, John S. Ramsey, and William L. Shelton for their critical review and comments.

MATERIAL AND METHODS

Sampling Areas with Hydrologic and Physical Data

Channel catfish were collected from six sampling areas within the river systems in 1969 and 1970. These areas included two impoundments on rivers with differing mineral content, three sections of the rivers partitioned by navigation locks and dams, and the confluence of the two drainages in an unrestricted delta area. These areas are shown in Figure 1 and will be referred to by their numerical designation.

Table 1 shows pertinent hydrologic and physical data of sampling sites. Measurements of water quality were obtained from Cherry (1963), whose data were collected in the spring through early fall 1960. Mineral content is expressed in parts per million (ppm) of total dissolved solids. Cherry (1963) reported that the mineral content is one of the best indicators of overall water quality and in most of the streams in Alabama is less than 500 ppm. Hardness is expressed as ppm of calcium carbonate.

Collection of Fish and Data

An attempt was made to obtain a sample of approximately 100 fish from each sample area per year, randomly distributed by size and age. Fish were collected from Areas 1, 2 and 6 with a trammel net and eight monofilament gill nets (stretch mesh 4.0, 5.0, 6.0 and 6.5 cm). The nets were set at dusk and checked periodically, or were left until early morning to remove captured fish. In Areas 3, 4 (Spencer, et al. 1966; Swingle, et al. 1966) and 5, where an intensive fishery exists, samples were obtained from commercial fishermen.

In the field, the total length of each fish was measured to the nearest millimeter on a standard measuring board. Fish weighing less

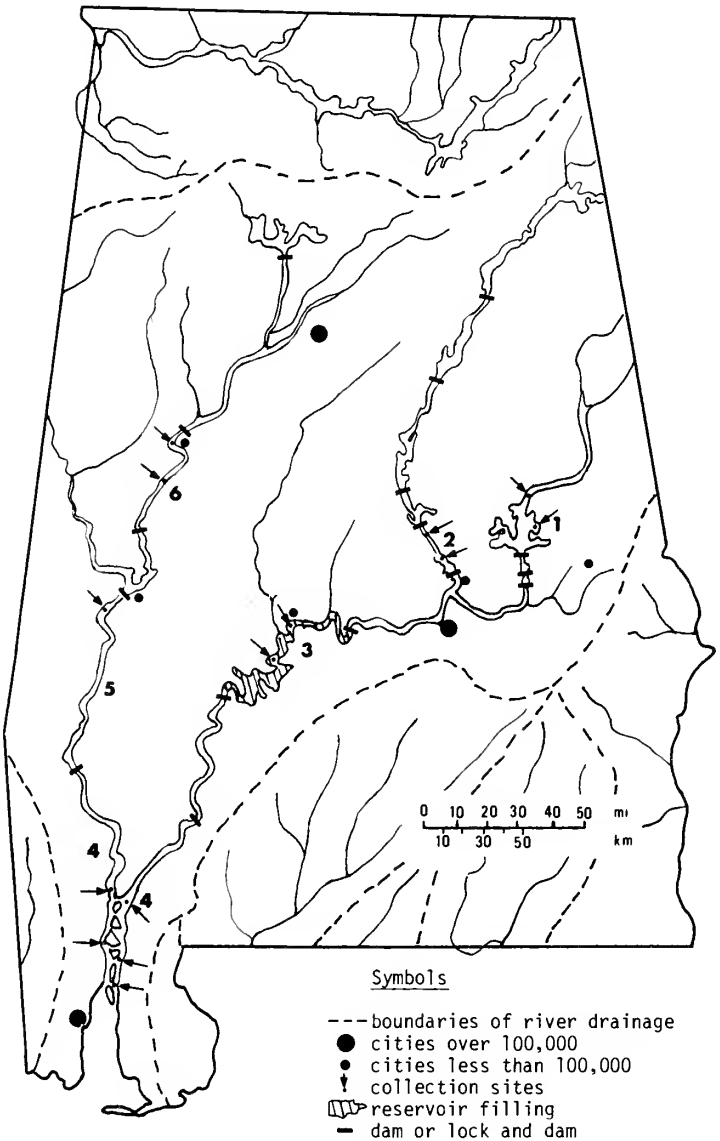

Figure 1. Map of Alabama showing river drainages and six sampling areas.

Table 1. Six sampling areas with hydrologic and physical data

Area	Date dam completed	Purpose	Average depth (ft)[1,2]
1-Lake Martin	1926	hydroelectric flood control recreation	41.4
2-Lake Jordan	1929	hydroelectric flood control recreation	36.5
3-Alabama River			
Jones Bluff L&D	1972	navigation flood control hydroelectric	19.3
to			
Millers Ferry L&D	1969		
4-Mobile Delta			
up to Coffeeville L&D	1960	navigation flood control	rivers 19 lakes 2-11
and			
up to Claiborne L&D	1969		
5-Tombigbee River			
Coffeeville L&D	1960	navigation flood control	22.4
to			
Demopolis L&D	1954		
6-Warrior River			
Warrior L&D	1957	navigation flood control	6.4
to			
Oliver L&D	1939		

Table 1. (continued)

Surface area(acres)[1,2]	Mineral content(ppm)[3]	Hardness(ppm)[4]	Pollution sources
39,184	25-34	11	domestic agriculture
6,628	75-110	52-81	domestic agriculture industry
17,200	55-78	32-57	agriculture domestic industry
31,549	66-97	46-57	heavy industry domestic agriculture
8,500	68-94	52-61	agriculture domestic industry
7,800	69-144	46-94	heavy industry domestic agriculture

Table 1. (continued)

Average flow(cfs)[5]	Additional comments
4,688	extensive drawdown (10 ft.) for winter flood control. definite oxygen and temperature stratification during summer.
15,980	slight drawdown (2-3 ft.) in fall for maintenance on dam. slight oxygen and temperature stratification during summer.
31,540	9 ft. channel dredged and maintained for navigation. reservior being stabilized during study period.

53,230	[2]reported salinity (0.1 ppt in spring, 3.0-5.0 ppt in late summer and fall) extending up to river mile 21 on the Mobile River.
26,230	9 ft. channel dredged and maintained for navigation.
7,652	[3]sulfate readings of 22-66 ppm reflect industrial pollution. [6]approximately 3,600 lbs. of BOD discharged from domestic sewage treatment plant daily.

[1]U.S. Army Corps of Engineers, 1973.

[2]Spencer, et al., 1966.

[3]Cherry, 1963.

[4]Hardness (0-31 very soft, 31-60 soft, 61-120 moderately hard, 120 and above, hard).

[5]U.S. Geological Survey flow data, 42-50 year averages.

[6]Alabama Water Improvement Commission. 1965. Pollution studies in the Warrior River near Tuscaloosa, Alabama. unpubl. rept.

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than 500 grams were weighed to the nearest two grams on a dietetic scale. Fish weighing more than 500 grams were weighed to the nearest 0.01 pound on a portable platform scale. Each fish was dissected for sex determination and was identified as immature, male or female. If eggs were present, the ovaries were removed and preserved in 10 percent Formalin for laboratory analysis. The left pectoral spine was removed by relaxing or loosening it in its socket, folding it posteriad and wrenching it in a counter-clockwise direction. Pectoral spines were placed in individual coin envelopes upon which data was recorded. If a commercial fisherman had a catch of more than 50 fish, a selected sample of 20 to 30 percent was taken to obtain data, including specimens from all size groups present. In most cases the catch was small enough (less than 50 fish) that data were collected and body parts removed from all fish before returning them to the fisherman at his processing station.

Age and Growth Determinations

Analysis of growth rings or annuli on pectoral spines was used to determine the age of channel catfish (Sneed, 1951). A small jeweler's saw mounted on a stationary platform was used to section the spines (Witt, 1961). Spines were sectioned at the distal end of the basal groove to maintain consistency (Jearld, 1970; Marzolf, 1955; Morris, 1960; Muncy, 1959; Russell, 1965). Sections of 0.5 to 0.6 mm thickness seemed optimum for reading. Each spine section was mounted between two glass slides secured with drafting tape. To insure good light

refraction for annulus reading, 95 percent ethanol was squirted between glass slides (Probst and Cooper, 1955). The spine sections were viewed under a binocular dissecting microscope and ocular measurements were converted to the nearest 0.01 mm. Measurements to each annulus and to the radius were made along the longer axis of the spine section from the center of the lumen. Only those growth rings visible around the entire spine, and not present only in one edge, were considered as true annuli (Muncy, 1959). Spines that showed malformed annuli were discarded. In some older fish the lumen had eroded into the first annulus. In these situations the first annular distance was not measured. Spines from fish that were collected in the spring were viewed closely to determine when the annulus was formed. Fish collected after January 1, but before the formation of the next annulus were assumed to be one year older (Hile, 1948). If the radial distance between the last annulus and the margin was proportionally too great compared to similar size specimens obtained on the same collecting date, then the total length was designated as the length at last annulus formation (Sneed, 1951).

The body-spine relationship has been described as a linear relationship by some (Sneed, 1951; DeRoth, 1965) and as a curvilinear relationship by others (Marzolf, 1955; Morris, 1960; Russell, 1965). Jearld (1970) calculated both linear and curvilinear regressions on this relationship. In the present study linear regression was tabulated on the spine radius-total length and was considered valid if plotted values showed a good fit and there was a high correlation (correlation coefficient $r > 0.75$). An intercept (a) at a point other than zero or Frasier's correction factor (Rounsefell and Everhart, 1953) was calculated for each area per sampling year. The formula used in back-calculating growth for each fish was:

$$L_i = a + \frac{S_i \quad (L_c - a)}{S_c}$$

L_i = length of fish at annulus i

a = intercept value of linear body-spine regression

S_i = distance to spine annulus for *ith* year

S_c = distance to spine radius at capture

L_c = length at capture

Before growth was calculated for each area, variance and covariance analyses were calculated to test for homogeneity of slopes (b values) and of intercepts (a values) in the spine radius-total length relationships. The presence of homogeneity or heterogeneity in the within-or between-area relationship determined whether pooled intercepts were used in back-calculating growth. Back-calculated length at annulus

formation and average length at each annulus were determined for each area. Duncan's new multiple range test was utilized to detect significant differences between treatment means at the 5 percent level of probability.

Length-Weight Relationships

The weight of fish is usually considered a function of its length and the relationship is represented by the following formula:

$$W = aL^b \qquad \text{where:}$$

W = weight

L = length

a and b are constants

Usually the constant b will be near 3.0 since fish weight will vary as the cube of fish length if its form and specific gravity remain the same. However, body proportions of fishes often change during their life and the constant b will change accordingly and vary from 3.0 (2.5 to 3.5) (Tesch, 1968). By plotting the length (X axis) against the weight (Y axis) an empirical curve can be determined for a population of fish based on representative sampling. From this curve unknown weight or length of a fish could be determined if only one value were known. The above relationship can also be expressed logarithmically:

$$\log W = \log a + b \log L \qquad \text{where:}$$

W = weight in grams

L = total length in millimeters

a and b are constants

The values of a and b may be determined by regressing log weight against log length. Plotting the log of weight against log of length gives a straight line regression which is easier to compare with regression areas from other areas. The log length-log weights were punched in IBM cards and relationship was calculated for each area, per year.

Variance analyses were calculated to test for homogeneity between slopes and between log a values within each area, per year. Covariance analyses were calculated to test for homogeneity between slopes and between log a values between areas.

DISCUSSION AND CONCLUSIONS

Collection of Fish

The treated trammel net did not capture adequate numbers of channel catfish. Fish probably avoided capture by this gear because of the combination of odors incorporated into the mesh. The monofilament nets were highly successful in capturing specimens in Areas 1, 2 and 6. The same monofilament nets captured large blue catfish, *Ictalurus furcatus*, and flathead catfish, *Pylodictus olivaris*, on numerous occasions in the same locations. Fish obtained from the commercial sources in Areas 3, 4 and 5 were generally larger than fish obtained by gill netting (Table 2). The commercial slat boxes and trot lines were selective for larger fish (Posey and Schafer, 1965; Starrett and Barnickol, 1955).

The minimal sample of 100 fish was not obtained in several areas (Table 2). Channel catfish were extremely difficult to collect in Area 2 for both years and in Area 6 for 1969. In Area 6 during 1969 adequate samples were not collected in heavily polluted industrial locations, therefore, collection sites downstream were sampled which provided increased catches. The commercial source in Area 5 was experiencing sporadic catches during 1969 and was planning to move operations to a new location. Therefore, an excessive sample was collected.

Age and Growth

Fish were collected too sporadically from all sampling areas in this study to determine the actual time of annulus formation in Alabama. By comparing the distance between the last annulus and the radius, it appeared that the annuli are formed between April and mid-July. Actual annulus formation at time of capture was evident in only six fish during both sampling years. These fish were collected on March 19, May 21, June 10 and July 9. A total of 32 fish collected from April 15 through July 16 showed recent annulus formation.

High correlation ($r = 0.84$ to 0.98) for each of the spine radius-total lengths tabulated by linear regression suggested good fit. For Area 1 through 3 and Area 6, variance analyses showed that there were no significant differences between slopes ($P > 0.05$) and between intercepts ($P > 0.05$); therefore, common values for these areas were computed. For Area 4, variance analyses showed that there were significant differences between slopes ($P = 0.0162$) and between intercepts ($P = 0.0020$). Common values were not calculated for this area. The heterogeneity within these values for Area 4 were attributed to biases sampling, resulting in fitting slopes and extrapolating the intercepts (38.76 and -28.08) which were significantly different. Perry (1966) faced a similar problem when back calculating growth rates for channel catfish collected from the tidal bayou complex of Rockefeller Wildlife Refuge, Vermillion Parish, Louisiana. He attributed this problem to error from sample size (Sneed, 1951) and from non-separation of sexes (Beaver, et al. 1966). In comparing growth, he assumed a zero intercept and reported that channel catfish in areas of high and low salinities grew about the same.

Table 2. Ranges of total length and weight of channel catfish collected in 1969 and 1970

Area	Year	No. fish collected	Range TL(mm)	Range in weight (g)
1	1969	97	187-397	46-514
1	1970	93	154-420	24-648
2	1969	30	115-375	24-448
2	1970	65	150-392	20-486
3	1969	102	187-554	46-1474
3	1970	100	262-580	106-1583
4	1969	102	228-443	100-862
4	1970	109	186-482	38-1007
5	1969	230	138-535	18-1560
5	1970	-	-	-
6	1969	72	124-412	10-614
6	1970	103	135-480	16-1126

Length-frequency distributions (Table 3) showed that captured fish increased in length for successive age groups, validating the spine-aging method. The variability of length of fish within each age group was attributed to differences in the time of year when fishes were caught. Age group I through V were represented in all areas. Age group VI was represented in Areas 2, 3, 5 and 6 while age group VII was present only in Area 3. Largest collections were in age group II through IV. The absence of age groups above VII in this study could reflect shorter life span due to longer growing season and warmer temperature. Increased temperature results in greater metabolic turnover of nutrients and usually shorter life of fish. Also longer growing season results in greater annual fishing and natural mortality if the instantaneous growth rates are greater during the growing season than the rest of the year (Carlander, 1966).

Table 4 presents the calculated lengths at each annulus of fish by age group for each area and the average calculated length at each annulus. As previously stated, Area 4, was treated as two separate areas (1969 and 1970 samples) since there were significant differences between slopes and between intercepts for the body-spine relationships for both years. The average calculated length at each annulus was determined from individual fish and not from the weighted or unweighted mean of each age group. For example, the average calculated length at annulus 1 for fish from Area 1 was computed using the calculated lengths at annulus 1 of all fish taken in the area in 1969 and 1970 regardless of age. Lengths at annulus 1 as calculated from individual fish in Ages I, II, III, etc., were used to compute the grand mean for the area. Analyses of variance revealed that there were significant differences ($P = 0.001$) between calculated length at each annulus in the different sampling areas.

Duncan's new multiple range test was used to detect significant differences at the 5 percent level for calculated length at each

Table 3. Length-frequency distribution of channel catfish

Length at capture (mm)	Age groups I	II	III	IV	V	VI	Total
			Area 1 (Lake Martin)				
0-99	1						1
180-199	2	8					10
200-219	3	6					9
220-239	2	13	2				16
240-259	3	32	3				38
260-279		32	4				36
280-299		15	6				21
300-319		7	7	3			17
320-339			3	3	2		8
340-359			6	2	1		9
360-379			4	5			9
380-399			3	5	3		11
400-419				2	1		3
420-439				1			1
Total	11	113	38	21	7		190
			Area 2 (Lake Jordan)				
100-119	1						1
120-139							0
140-159	1						1
160-179	7						7
180-199	2	3					5
200-219		13	1				14
220-239		8	6				14
240-259		4	11	3			18
260-279			8	6	1		15
280-299			2	2	1		5
300-319				2	3		5
320-339					2		2
340-359				1			1
360-379				5		1	6
380-399					1		1
Total	11	28	28	19	8	1	95

Table 3. (continued)

Length at capture (mm)	I	II	III	IV	V	VI	VII	Total
			Area 3 (Alabama River)					
180-199	2							2
200-219		2						2
220-239		3	1					4
240-259		4						4
260-279		7	3					10
280-299		4	7					11
300-319		5	10	1				16
320-339		4	10	1				15
340-359		2	10	4				16
360-379		4	9	9	1			23
380-399			9	9	1			19
400-419			2	9				11
420-439			3	8	3			14
440-459			3	6	1			10
460-479			1	3	1	3		8
480-499			3	5	1	3		12
500-519				2	2	4		8
520-539				2	3	4	1	10
540-559					1	2	1	4
560-579					1			1
580-599						2		2
Total	2	35	71	59	15	18	2	202
			Area 4 (Mobile Delta)					
180-199	1							1
200-219	1	1						2
220-239	2	10	3					15
240-259		14	7					21
260-279		11	16	1				28
280-299		7	19	2				28
300-319		4	19	4				27
320-339		1	8	7				16
340-359			13	5	2			20
360-379			4	9	1			14
380-399		1	5	7	1			14
400-419			1	9	3			13
420-439			2	3	1			6
440-459			1	2	2			5
460-479								0
480-499				1				1
Total	4	49	98	50	10			211

Table 3. (continued)

Length at capture (mm)	I	II	III	IV	V	VI	Total
			Area 5 (Tombigbee River)				
120-139	1						1
140-159	13						13
160-179	12						12
180-199	11						11
200-219	13	5					18
220-239	5	23					28
240-259	1	25	4				30
260-279		5	7	3			15
280-299		3	22	9			34
300-319		4	11	3			18
320-339		1	6	5			12
340-359		1	5	11			17
360-379			4	6			10
380-399			3	1			4
400-419			2		1		3
420-439					2		2
440-459					1		1
460-479							0
480-499							0
500-519						1	1
Total	56	67	64	38	4	1	230
			Area 6 (Warrior River)				
120-139	12						12
140-159	11						11
160-179	3	1					4
180-199	6	3					9
200-219	2						2
220-239	1	3					4
240-259	1	12	1				14
260-279		9	3				12
280-299		6	3				9
300-319		4	13	5			22
320-339		4	4	6			14
340-359			3	8			11
360-379			5	5	2		12
380-399			2	9			11
400-419				10	4	1	15
420-439				7	1		8
440-459							0
460-479					3		3
480-499				1	1		2
Total	36	42	34	51	11	1	175

Table 4. Back-calculated total length (mm) at each annulus from pectoral spine measurements of channel catfish

Areas	Grand mean total length at each annulus 1	2	3	4	5	6	7
1-Lake Martin	64	175	267	331	357		
2-Lake Jordan	42	128	202	253	288	349	
3-Alabama River	65	187	285	363	419	472	526
4/69-Mobile Delta	111	202	286	340			
4/70-Mobile Delta	37	137	268	361	398		
5-Tombigbee River	35	125	220	284	342	368	
6-Warrior River	58	166	265	333	399	388	

annulus (Table 5). Values were ranked from highest to lowest at each annulus. The presence of a vertical line or overlapping lines across two or more values indicated that they were not significantly different from each other. By ranking the values it appeared that the position of calculated lengths for Area 4/69 and 4/70 were quite erratic. Since an unknown error was introduced in calculating length at each annulus for Area 4, these values were not considered in making comparisons with other areas. By disregarding Area 4, there appeared to be a definite ranking in calculated length at each annulus between areas. At each annulus, calculated length for fish from Area 3 were the highest values compared to all other areas. Consistently low calculated lengths at each annulus were present in Area 5 and in Area 2. At each annulus, values for Area 3 were significantly higher compared to Areas 5 and 2. Values for Area 1 and for Area 6 were intermediate between Area 3, and Areas 5 and 2.

The growth curves of channel catfish from all sampling areas exclusive of Area 4 as fitted by eye in Figure 2 indicate that fish from Area 3 had the highest calculated length at each annulus. Channel catfish from Area 5 and Area 2 had the lowest calculated lengths. Fish from Area 1 and from Area 6 showed intermediate calculated lengths. Water quality and environmental data for prior years obtained from the U.S. Geological Survey and from the Alabama Power Company were either incomplete or not applicable for this study. Therefore valid comparisons and correlations to fish growth could not be analyzed by multiple covariance analyses. Jearld (1970) reported that to make valid comparisons of water level and calculated growth and show significant correlation, it would be necessary to have 30 years of average water levels and mean fish length. With the absence of this extensive data, the reasons for these distinct differences in growth between areas are only speculative. The presence of highest calculated lengths of fish from Area 3 suggest that the filling of Millers Ferry Reservoir provided optimum growing conditions compared to the other sampling areas. Low calculated lengths of fish were present in Area 5 and in Area 2. Conversations with commercial fishermen using slat boxes and/or gill nets based on seasonal success in Area 5, revealed that only small channel catfish (less than 5 pounds) had been caught in recent years, while

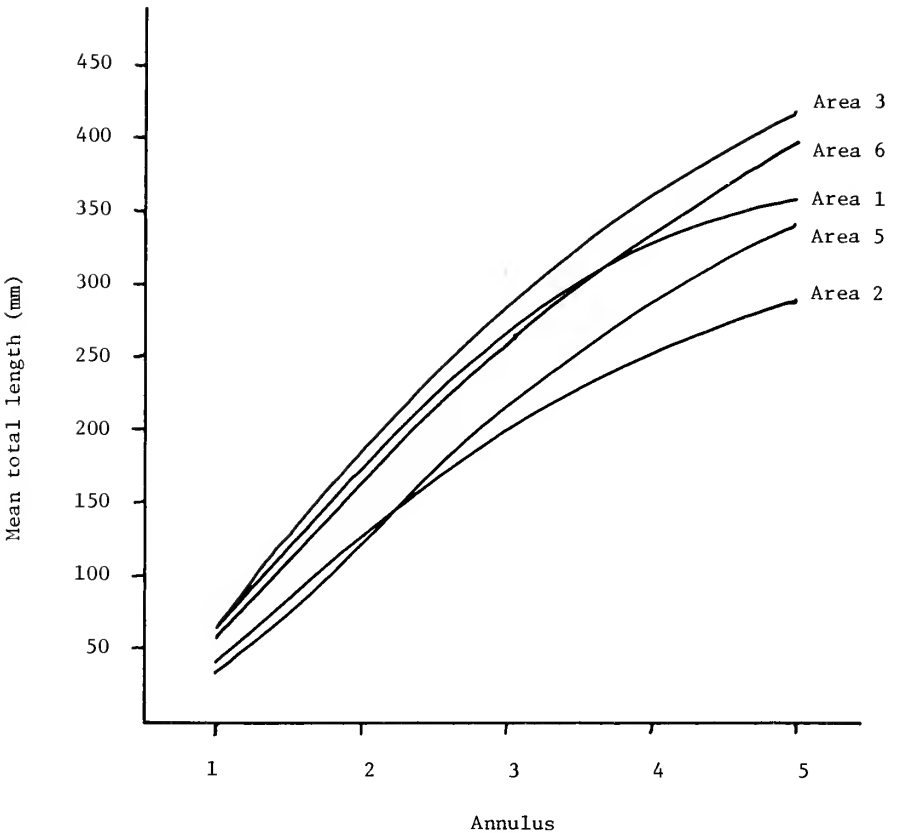

Figure 2. Comparison of growth curves for channel catfish from sampling areas in Alabama

medium to large blue catfish were common. I frequently viewed medium to large blue catfish from commercial catches in this area which suggested the possibility that interspecific competition might exist. The lowest calculated lengths of fish were obtained in Area 2. In Area 2, the trammel and monofilament gill nets collected only small channel catfish, while medium to large blue catfish were frequently caught. Local sport fishermen reported that large blue catfish were frequently caught, whereas only "squealer" size (1 pound or less) channel catfish were hooked. Commercial gear in Area 2 was restricted to trot lines. I suggest that interspecific competition exists between these two catfish species. Channel catfish collected in Area 6 and in Area 1 showed intermediate calculated lengths at each annulus. The presence of extensive industrial pollution and noxious conditions in Area 6 would not be expected to provide optimum environmental conditions for catfish growth. Many of the channel catfish collected in Area 6 were found within 3 miles of the Tuscaloosa domestic sewage discharge which provided a nutrient source to the productivity of this river. The trammel and monofilament gill nets frequently collected medium-size blue catfish. Blue catfish were not present in the Tallapoosa River drainage above the Fall Line at the time of this study, therefore, the absence of this species in Area 1 would have prevented interspecific competition between the two catfish species, allowing channel catfish to grow at a faster rate. Intermediate growth in the absence of competition is probably influenced by the low mineral content of the watershed.

Table 5. Duncan's new multiple range test to detect significant differences at the 5% level between total length at each annulus (A) by area

A1	Area	A2	Area	A3	Area	A4	Area	A5	Area
111	4/69	202	4/69	286	4/69	363	3	419	3
65	3	187	3	285	3	361	4/70	399	6
64	1	175	1	268	4/70	340	4/69	398	4/70
58	6	166	6	267	1	333	6	357	1
42	2	137	4/70	265	6	331	1	342	5
37	4/70	128	2	220	5	283	5	288	2
35	5	125	5	202	2	253	2		

Length-Weight Relationship

Carlander (1969) reported that the slope for the length-weight relationship of larger species of catfish (channel, blue, white and flathead) was usually greater than 3.0 (2.9 to 3.8) since these species characteristically increase in plumpness with increase in length. The slopes, log a values, and correlation coefficients (r) for each area per year are presented in Table 6. Analyses of variance revealed that there were significant differences between slopes ($P > 0.01$) and between log a values ($P > 0.01$) within Areas 1 and 2. There were no significant differences between slopes ($P > 0.01$) and between log a values ($P > 0.01$) withing Areas 3, 4 and 6.

Covariance analyses revealed that there were significant differences ($P = 0.001$) between areas during 1969 and 1970. Duncan's new multiple range test (Table 7) showed that the slope (2.65) and log a value (-4.3085) for Area 2 were significantly different at the 5 percent level from the slopes and log a values of the other five sampling areas during 1969. Also the test showed that the slope (2.31) and log a value (-3.4690) for Area 1 during 1970 differed significantly from the other five sampling areas. No valid conclusions could be drawn concerning the significant differences between slopes within Areas 1 and 2 from these data.

A comparison was made of the number of fish obtained from Areas 1 and 2 at each collecting month (Table 8). Inadequate representation in each length group in each of these two areas prevented drawing valid comparisons within these two areas per year since insufficient data on variables such as sex, age, sexual maturity, food availability could not be tested statistically. The significant differences between slopes within Areas 1 and 2 per year was attributed to sampling bias.

Table 6. Slopes (b), log a values and correlation coefficients (r) in length-weight relationships (log W = log a + b log L) of channel catfish

Area	Year	b	Log a	r	No. fish collected
1	1969	3.07	-5.3436	0.97	97
1	1970	2.31	-3.4690	0.90	93
2	1969	2.64	-4.3085	0.96	30
2	1970	3.15	-5.5238	0.99	65
3	1969	3.20	-5.6239	0.99	102
3	1970	3.34	-6.0194	0.99	100
4	1969	3.22	-5.6119	0.98	102
4	1970	3.30	-5.8784	0.97	109
5	1969	3.14	-5.5455	0.99	230
6	1969	3.18	-5.5938	1.00	72
6	1970	3.27	-5.8217	0.99	103

Table 7. Duncan's new multiple range test for significant differences at the 5% level between slopes and between log a values in length-weight relationships

Area	b	Area	Log a
	1969		
4	3.22	2	-4.3085
3	3.20	1	-5.3436
6	3.18	5	-5.5455
5	3.15	6	-5.5938
1	3.07	4	-5.6119
2	2.65	3	-5.6239
	1970		
3	3.34	1	-3.4690
4	3.30	2	-5.5238
6	3.27	6	-5.8217
2	3.15	4	-5.8784
1	2.31	3	-6.0194

Table 8. Numbers of channel catfish collected by month for Areas 1 and 2

Area	Year	Ap	M	Ju	Jl	A	S	O	N	Total
1	1969		5	24			1	5	62	97
1	1970	19		16	28		10	20		93
2	1969				4		2	15	9	30
2	1970	3	20	13		7	13	7	2	65

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Journal of the Alabama Academy of Science

A POLAR COORDINATE TRANSFORMATION FOR NONHOMOGENEOUS DIFFERENTIAL SYSTEMS

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ABSTRACT

This note establishes a polar coordinate transformation for a nonhomogeneous, second order differential system. On the basis of this transformation, oscillation and boundedness theorems are obtained for solutions of the system.

INTRODUCTION

The polar coordinate transformation has been a valuable tool in studying oscillation and boundness properties of solutions of second order homogeneous differential systems. The first published use of this transformation was that of H. Prüfer and the substitution has been fundamental in the work of J. H. Barrett [1], W. M. Whyburn [4], E. Kampke [3], and many others.

In this note, the second order nonhomogeneous differential system

$$y' = k(x)z + h(x)$$

$$x' = g(x)y + f(x) \tag{1}$$

is considered. A polar coordinate transformation will be established and oscillation theorems will be obtained by means of this transformation.

The Polar Coordinate Transformation

Throughout this paper it is assumed that the coefficients $k(x)$, $h(x)$, $g(x)$, and $f(x)$ of (1) are continuous functions on the half-axis $[a,\infty)$.

Theorem 1. Suppose $\{y(x),z(x)\}$ is a solution pair of (1) such that $y^2(x) + z^2(x) > 0$ on $[a,\infty)$. Then there exists a unique pair of functions $\{r(x),v(x)\}$ with the property that $y(x) = r(x) \sin v(x)$ and $z(x) = r(x) \cos v(x)$. Furthermore, $r(x)$ and $v(x)$ satisfy the differential system.

$$r'(x) = r(x)\,[k(x) + g(x)] \sin v(x) \cos v(x) + h(x) \sin v(x) + f(x) \cos v(x), \tag{2}$$

(3) $v'(x) = k(x)\cos^2 v(x) - g(x)\sin^2 v(x) + [h(x)\cos v(x) - f(x)\sin v(x)]/r(x)$, with $r(a) > 0$ and $0 \le v(a) \le 2\pi$.

Proof. If it is supposed that $r(x)$ and $v(x)$ exist and we put

$$y(x) = r(x)\sin v(x)\ ;\ z(x) = r(x)\cos v(x), \tag{4}$$

then it follows that $r' \sin v + rv' \cos v = kr \cos v + h$ and $r' \cos v - rv' \sin v = gr \sin v + f$. Solving these equations we obtain (2) and

$$rv' = r(k\cos^2 v - g\sin^2 v) + h\cos v - f\sin v. \tag{5}$$

since $r(x) = [y^2(x) + z^2(x)]^{1/2}$ and $y^2(x) + z^2(x) > 0$ on $[a,\infty)$, $r(x) > 0$ on $[a,\infty)$ and (3) follows.

Using standard existence and uniqueness theorems (see e.g. [2, Chap. 2]), the system (2), (3) is seen to have a unique solution pair $\{r(x), v(x)\}$. It is now easily verified that if $\{r(x), v(x)\}$ is a solution of (2), (3) satisfying initial conditions $r(a) > 0$, $0 \le v(a) \le 2\pi$ then the functions $y(x) = r(x)\sin v(x)$, $z(x) = r(x)\cos v(x)$ form a solution pair of (1) with the property that $y^2 + z^2(x) > 0$ on $[a,\infty)$, only when $r(x) \neq 0$.

The requirement that $y^2(x) + z^2(x) > 0$ on $[a,\infty)$ was made to insure that $r'(x)$ and $v'(x)$ are defined for all values of x. For if we put $y(x)$ and $z(x)$ in polar form (4), then $r = (y^2 + z^2)^{1/2}$, and $r' = [(k + g)\sin v \cos v + h \sin v + f \cos v]r/r$. Hence, if $y(x_0) = z(x_0) = 0$ for some x_0 on $[a,\infty)$, then $r'(x_0)$ is undefined, and from (3), $v'(x_0)$ is also undefined. However, a slight generalization is obtained in the following.

Theorem 2. Suppose $\{r(x), v(x)\}$ is a solution pair of (2), (5), satisfying the initial conditions $r(a) \ge 0$; $0 \le 2\pi$. Then the pair of functions $y(x)$, $z(x)$ defined by (4) is a solution of (1) such that $y^2(x) + z^2(x) \ge 0$ on $[a,\infty)$.

Oscillation and Boundedness

We can now apply the polar coordinate transformation to obtain oscillation and boundedness results for (1).

Theorem 3. Suppose $k(x) > 0$ and $h(x) \equiv 0$ on $[a,\infty)$. If $r(x)$ is nonoscillatory on $[a,\infty)$, then $y(x)$ is oscillatory if and only if $v(x) \to \infty$ as $x \to \infty$.

Proof. If $r(x)$ is nonoscillatory, then on any interval $[b,\infty)$ where $r(x) \neq 0$, $y(x) = 0$ if and only if $v(x) \equiv 0 \pmod{\pi}$. Since $v'(x) = k(x) > 0$ when $y(x) = 0$, v is increasing at zeros of y, and the result follows.

We remark that if $k(x) = 1/p(x)$, $g(x) = -q(x)$, and $h(x) = 0$, then the system (1) is equivalent to the second order equation

$$(p(x)y')' + q(x)y = f(x). \tag{NH}$$

M. E. Hammett [4], has shown that when $f(x) \neq 0$ on $[a,\infty)$, then (NH) is nonoscillatory if the associated homogeneous equation

$$(H) \qquad (p(x)u')' + q(x)u = 0,$$

is nonoscillatory. However, if f is allowed to change signs, then this result is no longer true. For example, in equation (NH), put $p(x) = \exp(x)$, $q(x) = \exp(-x)$, and $f(x) = \exp(x)\cos x - 2\cosh x \sin x$. Then

$$\int_a^\infty \frac{dx}{p(x)} < \infty \; ; \; \int_a^\infty |q(x)|\, dx < \infty \text{ , and}$$

(H) is nonoscillatory. But (NH) has the oscillatory solution $y(x) = \sin x$.

As a corollary, a criteria for determining the nonoscillation of a solution of (NH) is obtained, even though f is not of one sign.

Corollary. Under the hypothese of Theorem 3, if $\int_a^\infty k(t)\,dt < \infty$, $\int_a^\infty |g(t)|dt < \infty$, and $\int_a^\infty |f(t)/r(t)|dt < \infty$, then y(x) is nonoscillatory on $[a,\infty)$.

The following theorem provides conditions under which r(x) is nonoscillatory.

Theorem 4. Suppose there is an integrable function M(x) on $[a,\infty)$ such that $|k(x)| \leq M(x)$, $|h(x)| \leq M(x)$, $|g(x)| \leq M(x)$, and $|f(x)| \leq M(x)$ for all x, Let $\{y(x),z(x)\}$ be a solution pair of (1) and let $\{r(x),v(x)\}$ be given by (2), (5). If $\int_a^\infty M(s)ds < \infty$, and $r(a) + 2 > 2\exp\int_a^\infty M(s)ds$, then $r(x) > 0$ on $[a,\infty)$.

Proof. Solving the first order, linear equation (2), one obtains

$$(6) \quad r(x) = \exp w(x)\{r(a) + \int_a^x [f(t)\cos v(t) + h(t)\sin v(t)]\exp(-w(t))dt\},$$

where

$$w(x) = \int_a^x [k(t) + g(t)]\sin v\,(t)\cos v(t)dt.$$

From (6), it is clear that $r(x) = 0$ only if the expression inside the braces is zero. Now $\left|\int_a^x (f\cos v + h\sin v)\exp(-w)dt\right| \leq 2\int_a^x M(t)\exp\int_a^t M(s)ds\,dt = 2\exp\int_a^x M(s)ds - 2.$

Hence if $\int_a^\infty M(s)ds < \infty$, and $r(a) + 2 > 2\exp\int_a^x M(s)ds$, then $r(x) > 0$ on $[a,\infty)$.

Corollary. Under the hypotheses of Theorem 4, the solution y(x) is bounded on $[a,\infty)$ by $r(a)[r(a) + 2]$.

Proof. Using equation (6) and the above inequalities, we see that

$$r(x) \leq [r(a) - 2 + 2 \exp \int_a^x M(s)ds] \exp \int_a^x M(s)ds.$$

Using this inequality and the hypothesis that $r(a) + 2 > 2 \exp \int_a^x M(s)ds$ on $[a,\infty)$, we obtain the desired result.

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Journal of the Alabama Academy of Science

THE CRANBERRY BOGS OF SHADY VALLEY, TENNESSEE

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ABSTRACT

Shady Valley was once the site of an extensive boreal cranberry bog habitat which presently is rare in Tennessee. Its location in the southern Appalachians make it a link between the boreal bogs in more southern localities and those in Canada. The purpose of this study was to locate remaining bogs and document some of their characteristics.

Shady Valley is a mountain cove located in Johnson County in the extreme northeast corner of Tennessee. The valley is about two and one-half miles wide by five miles long and its broad valley floor lies at an elevation of about 2,800 feet.

Shady Valley is the site of a rapidly disappearing boreal cranberry bog habitat which is rare in Tennessee. Its location in the southern Appalachians makes it a link in the chain of boreal bogs which extend from Canada (Barclay, 1957). This unique valley, reported as late as the 1920's to contain extensive areas of cranberry bogs is now practically devoid of them due to agricultural development (Gainer and Tyler, 1934).

After hiking over much of the valley and after numerous interviews with valley residents the author could locate only one small cranberry bog of about 1,800 square feet. This bog is fed by a small spring originating about 140 yards up a much dissected slope. The bog site evidently has not been considered worth the trouble of clearing and draining for agricultural due to its small size and inaccessibility.

The presence of this cranberry bog seemed noteworthy as such bogs are rare in Tennessee and little information is available concerning their characteristics. The following table illustrates some physical characteristics of the bog water samples:

Some Physical Characteristics of the Shady Valley Bog Water Collected in August, 1973.	
Characteristics of Bog Water	Mean Values of Five Random Samples
pH	4.9
Orthophosphates	negative
Total phosphates	.1 PPM
Dissolved oxygen	4.8 PPM
Total hardness	103.0 PPM
Volume of water flowing from bog area	15.0 gal./min.

The upper canopy of the bog presently consists of white pine, red maple, tulip poplar, and dogwood. The understory is composed of rhododendron, mountain laurel, sedges, cottongrass, bullrushes, poison sumac, mountain holly, cranberries (Vaccinim macrocarpum), and associated plants arising from a heavy carpet of sphagnum moss.

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COLCHICINE-INDUCED POLYPLOIDY IN *HEMEROCALLIS*

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ABSTRACT

Colchicine was applied to 96 cultivars of daylily by exposure to germinating seeds or by exposure to meristems after shoot decapitation. When diploid plants were treated it was observed that pollen grains and stomates increased in size to that which is characteristic for tetraploids. This apparent inducement of tetraploidy could usually be substantiated by chromosome counts, the number increasing from 22 to 44. Although an increase in size of various plant structures was indicative of induced polyploidy, examination of chromosomes was the most reliable method of ploidy analysis.

INTRODUCTION

There are approximately 40 species of *Hemerocallis* in the family *Liliaceae*. Each species is subdivided into varieties or cultivars. The term cultivar, now in general use for horticultural plants, is preferred when denoting intraspecific clones such as those of the daylily. The cultivars used in this study are probable descendents of the species *Hemerocallis fulva* L. and are registered with the *Hemerocallis* Society of America.

Colchicine-induced polyploidy of *Hemerocallis* was first obtained and reported by Traub (1951). Numerous investigators subsequently have worked with the daylily using various methods of colchicine treatment. These methods include treatment of shoots (Arisumi, 1964), injection of floral scapes (Buck, 1969), absorption through roots (Traub, 1951), and treatment of seeds (Griesbach, et al., 1963). Various criteria have been used to evaluate induced polyploidy in plants after colchicine treatment, including microscopic measurements of pollen grains and stomates, examination of mitotic chromosomes from root tips, and examination of meiotic chromosomes from developing stamens (Haskell and Wills, 1968).

Although literature is abundant on the general subject of induced polyploidy in plants, specific information on the effects of colchicine on the daylily is scant and incomplete. The purpose of this study was to determine the effects of colchicine on certain cultivars of *Hemerocallis*. These effects were studied with reference to chromosome changes and to changes in stomate and pollen size.

METHODS OF COLCHICINE TREATMENT

The *Hemerocallis* plants and seedlings used in this study were obtained through the Birmingham Botanical Gardens. A total of 96 cultivars were used. This number consisted of 66 natural diploids and 30 tetraploids.

Colchicine treatment of Diploid Seeds

Freshly harvested seeds were germinated at 24-26°C in petri dishes containing moist filter paper. Germination began within 3 to 5 days. Those seedlings having undergone bending of the embryo axis were placed in 10 cc vials and immersed in 0.05% aqueous colchicine for 12 hours. The seedlings were then transferred to a small cheesecloth sack and washed under running tap water for 6 hours. After washing, the seedlings were planted in peat pots with the seed coat and shoot portion above the soil level. Seedlings were later transferred to the greenhouse to obtain maximum growth. Somatic chromosome counts were routinely made on root tips according to standard procedures (Haskell and Wills, 1968).

Colchicine Treatment of Meristems

Polyploidy was also induced by adding colchicine to the meristem of a decapitated shoot. Forty-one healthy, fast growing potted plants were cut approximately one-half inch above the base of the aerial leafy stem. A scalpel was used to make a cup in the central portion of the stem approximately one-fourth inch in depth and diameter. Care was taken not to injure the delicate meristem of the rootstock. Each cup was filled with a 0.02% aqueous solution of colchicine which contained 3 drops of 10% Calgon wetting solution per 10 cc of colchicine. Three applications were administered at 48 hour intervals. The plants were not watered during the application. When the plants resumed vigorous growth, the day length was extended from 6 P. M. to 9 P. M. with fluorescent lights to accelerate growth rate. Plants were later transplanted from the greenhouse to the garden.

Measurement of Ploidy

In addition to chromosome counts, ploidy level was estimated by measuring diameters of pollen grains and leaf stomates. The greatest diameter of each of 10 pollen grains, taken at random, was measured at 400X with a phase contrast microscope. Stomates were measured from medium-sized leaves of seedlings that were at least 3 months old. Ten stomates, randomly selected, were measured from a stripped portion of lower epidermis. The largest diameter of each stomate was measured from the outside of one guard cell to the outside of the other.

RESULTS AND DISCUSSION

Colchicine Treatment of Diploid Seeds

The 2n number of *Hemerocallis* is 22, and the corresponding tetraploid has 44 chromosomes (Fig. 1). Out of 557 diploid seeds treated with colchicine, 266 (48%) survived. Of these, 67 remained diploid (2n), 106 were tetraploid (4n), and 93 were mixoploid (88 were 2n-4n; 5 were 4n-8n). Controls, consisting of chromosome counts from root tips of germinated seeds in the absence of colchicine, were prepared with each colchicine pre-treatment experiment to insure that original seed stocks were diploid.

In all, 75% of the diploid seedlings surviving colchicine treatment were induced to a polyploid state.

Figure 1. A typical diploid chromosome complement of *Hemerocallis* showing 22 chromosomes (left) and a corresponding tetraploid complement showing 44 chromosomes (right). 4500X

In addition to chromosome counts, ploypoidy was indicated by incresed sizes of leaf stomates and pollen grains from similar sized anthers (Table 1.). As shown, the modal stomate diameter of colchicine treated seedlings did not attain that for known tetraploids. However, 45 (9%) of the total number of seedlings treated exhibited stomates as large or larger than those of natural tetraploids. Suspected changes in structure from diploid to tetraploid level was verified by chromosome counts.

Table 1. Measurement of Stomates and Pollen Grains as Structural Parameters of Induced Tetraploidy.

	STOMATES		
Method of treatment	Number of plants	Number of stomates measured	Modal range of stomate size (microns)
Non-colchicined diploid seedlings	263	2630	34-40
Colchicined diploid seedlings	502	5020	38-42
Non-colchicined tetraploid seedlings	106	1060	45-52

Table 1. (continued)

	POLLEN GRAINS		
Method of treatment	Number of plants	Number of pollen grains measured	Modal range of pollen grain size (microns)
Non-colchicined diploid seedlings	62	620	116-125
Colchicined diploid meristems	125	1250	120-132
Non-colchicined tetraploid plants	30	300	139-149

A size increase similar to that of stomates was also found by comparing pollen diameters of colchicine-treated plants and natural tetraploids determined by chromosome counts of germinated seeds. Shoots from colchicined meristems produced slightly enlarged pollen grains as compared with diploid plants. The modal pollen diameter was intermediate between 2n and 4n plants (Table 1). Examinations of distributive frequencies in these plants showed 14% had pollen grains as large (139-149 microns) or larger than those of tetraploids. That the large pollen grains from reputed tetraploids were probably diploid was supported by the tetraploid chromosome complements found in root tips.

CONCLUSIONS

Colchicine treatment affects the percentage of survival and produces chromosome changes in various diploid *Hemerocallis* parentages. The degree to which embryonic cells are converted to a different chromosome complement (for example, tetraploid or mixoploid) is perhaps dependent on their metabolic states and/or the extent to which the colchicine can penetrate the various histogenic layers of meristematic tissues.

Modal sizes and ranges of stomates and pollen grains show a definite correlation with various levels of ploidy. As the level of ploidy increases there is a corresponding increase in the size of pollen grains and stomates. Each level of ploidy is thus characterized by modal value or range. These results support the findings of Peck and Arisumi (1968). This information may be of value to professional and amateur daylily breeders since such structural measurements can be made in the field where large scale crosses are made. It must be pointed out, however, that chromosome determination is the more accurate method for evaluating the *Hemerocallis* genome.

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A BIOGEOGRAPHIC ANALYSIS OF THE HERPETOFAUNA OF THE COOSA VALLEY IN ALABAMA

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ABSTRACT

Ninety-one species of amphibians and reptiles are known to occur within the Coosa Valley in Alabama. Seventy of these have extensive ranges in Alabama and occur both above and below the Fall Line. Ten species are considered to be of northern affinity, in that they occur mainly above the Fall Line. Eleven species are considered southern (or Lower Austral) in affinity, in that they occur mainly below the Fall Line.

The distributions of many amphibians and reptiles of the Coosa Valley are thought to be explainable on the basis of geologic history. Those species of widespread occurrence in Alabama appear either to have been affected little by Quaternary events, or to have had little difficulty re-populating areas of the southeastern United States after the Wisconsin glacial period. Species of northern affinity in the Coosa Valley probably had their recent centers of distribution in the remnants of the Arcto-Tertiary forests of the Appalachian highlands. Species of southern affinity in the Coosa Valley are considered relicts, having survived from a period when they were more widespread in northern Alabama. It appears that favorable soil conditions are the factors primarily responsible for the persistence of these relicts in the Coosa Valley.

INTRODUCTION

Mount (1964, 1972) and Mount and Folkerts (1968) noted the presence of animals in the Coosa Valley of Alabama that were found elsewhere chiefly in the Coastal Plain. Also, Harper (1943) described certain plant associations of the Coosa Valley that are typically found in the Coastal Plain. Mount (1972) stated that further study of the biogeography of the Coosa Valley was needed.

The goals of this study were to determine the species of amphibians and reptiles in the Coosa Valley and their zoogeographic affinities. In analyzing species distributional patterns, geology, topography, drainage systems, soils, climate, vegetation, and past geological and environmental conditions were considered.

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To determine species composition and subspecific allocation, specimens of forms known to occur in the Coosa Valley were examined from a 14-county area in northeastern Alabama (Fig. 1). This area includes the Coosa Valley, some of the other subdivisions of the Appalachian Ridge and Valley Province, and parts of the Coastal Plain, Piedmont, and Appalachian Plateaus provinces (Fig. 2). Specimens from physiographic areas adjacent to the Coosa Valley were examined to facilitate the determination of the subspecific status of Coosa Valley populations and to determine if Coosa Valley populations differ significantly from those of the same species in adjacent physiographic regions.

From February, 1972 to September, 1974, extensive field investigations were conducted to determine the distributions, habitat preferences, and seasonal activities of species in the Coosa Valley. Approximately 350 specimens were collected and deposited in the Auburn University Museum (AUM). Approximately 3,700 museum specimens were examined from the Auburn University Museum, Auburn University Museum of Paleontology (AUMP), University of Alabama Museum of Natural History (UANH), Jacksonville State University Museum (JSUM), and the National Museum of Natural History (USNM).

DEFINITION AND DESCRIPTION OF THE COOSA VALLEY

Definition

The Coosa Valley has been described and defined by Berney (1878), Smith (1883), McCalley (1897), Adams, *et al.* (1926), Johnston (1930, 1933), and Glazner (1938). Johnston (1933) divided the Appalachian Ridge and Valley Province in Alabama into the Birmingham-Big Canoe Valley District, Cahaba Ridges District, Cahaba Valley District, Coosa Ridges District, Coosa Valley District, and Weisner Ridges District (Fig. 3). For the purposes of this study, Johnston's definition was used with some modification (Fig. 2). The Coosa Valley District is included in parts of Bibb, Calhoun, Cherokee, Chilton, Coosa, Etowah, St. Clair, Shelby, and Talladega counties. It ranges from nearly 25 miles wide in northern Talladega County to just under 10 miles wide in southern Shelby and northwestern Chilton counties.

Topography and Geology

The formations of the Coosa Valley are composed of marine and marshland sediments deposited during the Paleozoic Era. Near the end of the Paleozoic these horizontal beds of limestones, shales, sandstone, and conglomerates were disrupted by complex folding and faulting due to the orogenic forces which formed the Appalachian Mountains (Johnston 1933). According to Bowman (1911) the present diverse topography of the area is a result of intermittent uplifts and subsequent denudation which occurred during the Mesozoic and Cenozoic eras. Adams, *et al.* (1926) listed and described all of the geological formations found within the Coosa Valley District.

In central Bibb and northwestern Chilton counties the Paleozoic strata of the Coosa Valley District gently dip under the Cretaceous deposits of

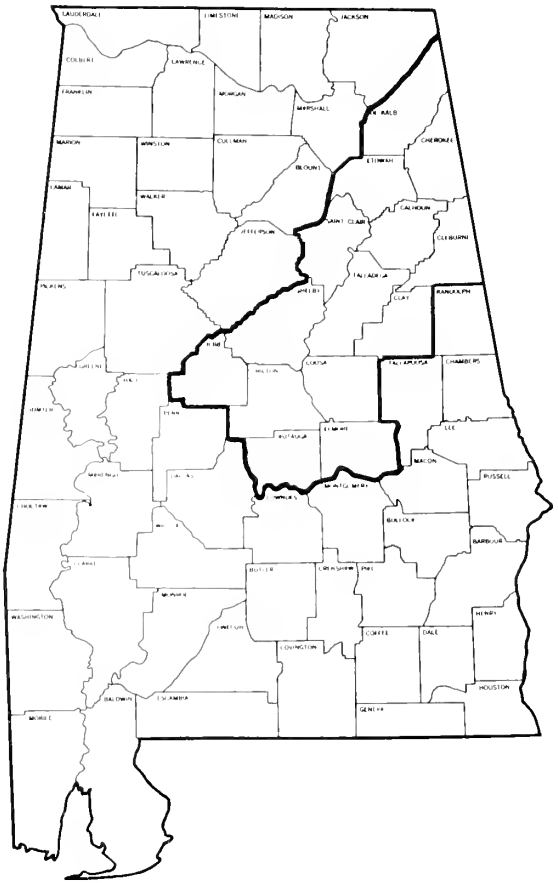

Figure 1. The fourteen-county area in Alabama (outlined) from which specimens were examined.

the Coastal Plain. In this area there is no great change in elevation, and the Fall Line is topographically indistinct.

Drainages

The major drainage system of the Coosa Valley District is the Coosa River System. A small area in the extreme southwestern portion of the District is drained by tributaries of the Cahaba River. In the past 60 years the Coosa River has been changed from a medium-sized, free-flowing river to a series of pools created by the construction of six dams by Alabama Power Company.

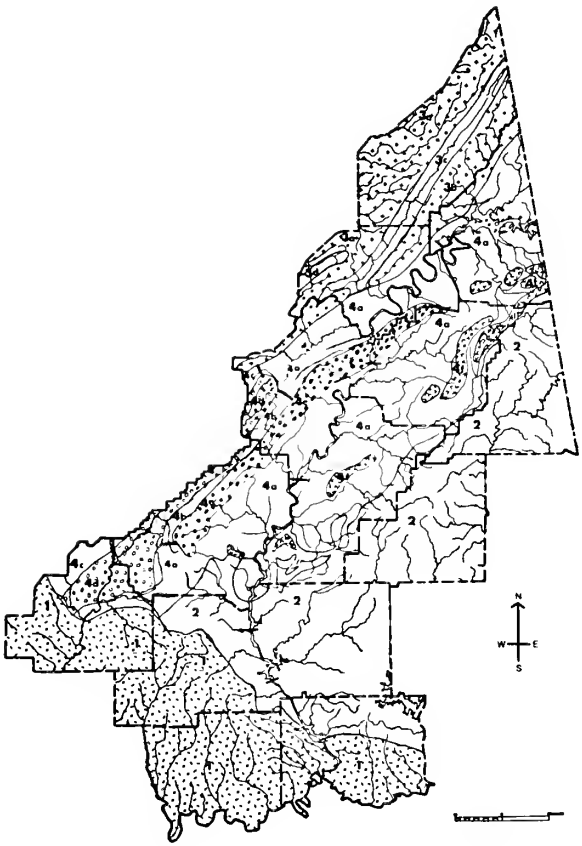

Figure 2. Physiographic features of the study area as modified from Johnston (1933). 1, Coastal Plain; 2, Piedmont; 3, Appalachian Plateaus; 3a, Sand Mountain District; 3b, Lookout Mountain District; 3c, Big Wills Valley District; 3d, Murphee's Valley District; 4, Appalachian Ridge and Valley; 4a, Coosa Valley District; 4b, Cahaba Valley District; 4c, Birmingham-Big Canoe Valley District; 4d, Cahaba Ridges District; 4e, Coosa Ridges District; 4f, Weisner Ridges District.

Soils

Soils of the Coosa Valley are considered to belong predominantly to the order of Utisols (Boul, 1973). Soils of this order generally have sandy or loamy surface horizons and most subsurface horizons are loamy or clayey in texture. Dominant great groups of the Utisols in the Coosa

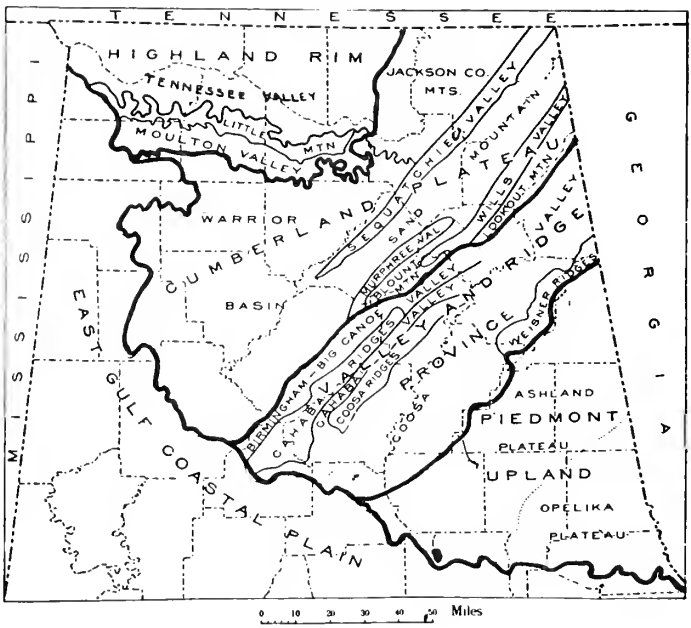

Figure 3. Physiographic divisions of northern Alabama (Johnston, 1933).

Valley are Paleudults and Hapludults. Paleudults are also the dominant Utisols of the Coastal Plain in Alabama.

According to B. F. Hajek, Department of Agronomy and Soils, Auburn University (pers. comm.), recent soil samples have revealed that some of the soils of the Coosa Valley, especially of the Holston-McQueen-Chewacla soil association, are morphologically indistinct from some soils of the Lower Coastal Plain in southeastern Alabama.

Climate

Weather data presented in the following account was taken from the Yearbook of Agriculture, United States Department of Agriculture (1941). The climate of the Coosa Valley is temperate. The summers, while warm, are not excessively hot, and severely cold winter weather seldom occurs. Freezing temperatures seldom continue longer than 48 consecutive hours.

The average January temperature in the northern portion of the Valley is 42°F and in the southern portion, 46°F. Throughout the Valley the average July temperature is approximately 80°F. The yearly number of frost-free days averages approximately 210 in the northern portion of the Valley and approximately 220 to 230 in the southern portion.

Precipitation, predominantly rain, averages around 54 inches yearly. Excessively heavy rains occur most often in late winter and early spring. However, tropical storms sometimes bring heavy rains in summer and fall. Thunderstorms are most frequent in summer, but may occur year-round. Average snowfall is approximately three inches per year, and it seldom remains on the ground more than two days at a time.

Vegetation

The plant species found within the Coosa Valley District include those that are common to the southern Appalachian region. According to the Society of American Foresters (1967), the forest types of the Coosa Valley are classified as Southern Forest types.

The level limestone valleys have been converted almost completely into pastureland and cultivated fields. The few forests left in their natural state in these level areas are predominantly bottomland hardwoods in stream floodplains and mixed pine-bottomland hardwoods in well-drained areas. Harper (1943) reported that in Cherokee and Etowah counties there were longleaf pine (*Pinus palustris*) flatwoods forests that resembled those of the Lower Coastal Plain. These longleaf pine flatwoods have been cut over, and much of the land is now devoted to pastures, cultivated fields, and loblolly pine plantations. Also, the formation of Weiss Reservoir inundated many of these flatwoods.

Forest types of ridges within the Coosa Valley include upland hardwoods, mixed pine-upland hardwoods, scrub hardwoods, and mixed pine-scrub hardwoods.

HERPETOFAUNA OF THE COOSA VALLEY

Species Composition

In most respects the herpetofauna of the Coosa Valley is typical of that of the southern section of the Appalachian Ridge and Valley Province. However, the Coosa Valley is peculiar in having several species whose ranges lie predominantly within the Coastal Plain. The 91 species of amphibians and reptiles known to occur in the Coosa Valley are listed in the Appendix.

Subspecific Variation

Twenty-eight monotypic species occur in the Coosa Valley. Forty-five polytypic species that occur in the Valley are represented by only one subspecies each. Eight polytypic species are represented by populations intergradient between two or more subspecies. The populations of eight species are mostly of a single subspecies, but in these, influence from another subspecies is evident in intergradient populations in some portion of the Coosa Valley. Two species are represented by two subspecies each, along with intergrades between the subspecies.

Problematical Forms

No specimens of *Necturus* were collected or examined from the Coosa or Cahaba river systems in the Coosa Valley. However, G. W. Folkerts, Department of Zoology-Entomology, Auburn University (pers. comm.) reported having seen a specimen from Weiss Reservoir in Cherokee County. Mount (1975) considers the reservoir to be within the range of one species, *N. beyeri*.

At present, no specimens of *Graptemys geographica* are available from the Coosa River drainage in the Coosa Valley. The species has been found in the Coosa River in the Piedmont of northwestern Coosa County. This record is approximately four miles south of the point where the Coosa River crosses the transition between the Coosa Valley and the Piedmont, and there is little doubt that the species occurs farther northward in the Coosa River. *G. geographica* also occurs in the Cahaba River in the Cahaba Ridges District.

Webb (1962) showed the range of *Trionyx muticus calvatus* to include the Coosa and Cahaba drainages of the Coosa Valley. *T. m. calvatus* occurs in the Mobile Bay drainage system but has not been collected above the Fall Line.

DISCUSSION

Past Environmental Conditions

According to Porter (1972) the fossil record indicates that nearly all extant North American amphibian and reptilian species groups were present p[illegible]or to the end of the Tertiary. He indicated that some present-day distributional patterns have existed since the Tertiary, but that many current patterns can be attributed to Quaternary events.

In contrast to the Tertiary, in which relatively stable, warm, moist climates predominated, the Quaternary has been characterized by climates which fluctuated widely in temperature. During the Quaternary there occurred four extensive glacial periods with intervening interglacial periods (Flint, 1947). Auffenberg and Milstead (1965) stated that the major ecological fluctuations affecting reptilian distributions in the Quaternary were "the expansion and contractions of frigid temperature zones, expansion and contraction of xeric and mesic climates, including the opening and closing of xeric and mesic dispersal routes, and the changes of sea level, including the influence of the Mississippi Embayment and the Florida Archipelago." They suggest that with each glacial period the northern limits of distribution of various reptiles were forced southward, followed by a return less far northward during each successive interglacial period.

These factors could also be the major ecological fluctuations that have affected the distributions of amphibians. Blair (1958) concluded that Urodela (salamanders) and Anura (frogs) responded differently to the climatic fluctuations of the Quaternary. He considers most urodeles adapted to cool, moist environments, while anurans are adapted to relatively warm climates. Blair concludes that urodeles would tend to

move southward with the cooler climates that fragmented the ranges of thermophilic anurans.

Historical Zoogeography

For purposes of this discussion the components of the herpetofauna of the Coosa Valley are categorized as follows: (1) species of widespread occurrence in Alabama, ranging above and below the Fall Line, (2) species restricted largely to areas above the Fall Line, and (3) species restricted largely to areas below the Fall Line.

In category one are 70 species, including 11 frogs, 12 salamanders, 10 lizards, 26 snakes, and 11 turtles. Quaternary environmental events are believed to have affected these species very little or, if there were major effects, these species are believed to have had little difficulty re-inhabiting areas of the southeastern United States from which they may have retreated.

There are 10 species, all amphibians, in the Coosa Valley which fall into category two (Fig. 4A-J). These include the anurans *Bufo americanus*, *Pseudacris brachyphona*, and *Rana palustris*, and the plethodontid urodeles *Desmognathus aeneus*, *Desmognathus monticola*, *Eurycea aquatica*, *Eurycea lucifuga*, *Gyrinophilus porphyriticus*, *Plethodon cinereus*, and *Plethodon dorsalis*. Blair (1965) stated that the plethodontids, as a group, have a recent center of distribution in the remnants of the Arcto-Tertiary forest of the Appalachian highlands. Although Blair considered most anurans to be "warmth-adapted," with a recent center of distribution in the extreme southeastern United States, the three species listed above have northerly ranges and appear to be "cool-adapted," as are most plethodontids. *Desmognathus aeneus*, *D. monticola*, *P. dorsalis*, and *R. palustris* have apparently disjunct populations below the Fall Line in Alabama (Fig. 4G-J). Smith (1957) attributed the phenomenon in which species of northern affinity have disjunct southern populations to Pleistocene climatic conditions. He postulated that northern forms extended their ranges far southward during a relatively dry, cool period, which he termed the "postglacial maximum (pine phase)." This period was followed by a warm, moist "climatic optimum period," which eliminated the southern populations, except for those of some species that survived as isolates in a few remaining areas of habitat suitable to them.

Category three contains 11 species (Fig. 5A-K). Five of these (*Bufo terrestris*, *Hyla cinerea*, *Hyla gratiosa*, *Ophisaurus ventralis*, and *Micrurus fulvius*) have populations above the Fall Line in upland provinces other than the Coosa Valley. Because *H. gratiosa* has many localized populations outside the Coastal Plain and Coosa Valley, its distribution is shown as statewide. The remainder (*Bufo quercicus*, *Hyla femoralis*, *Hyla squirella*, *Rana areolata*, *Heterodon simus*, and *Deirochelys reticularia*) exist above the Fall Line only in the Coosa Valley. The portions of the respective ranges of some of these species above the Fall Line are disjunct from the southern portions, while with others the range is apparently continuous.

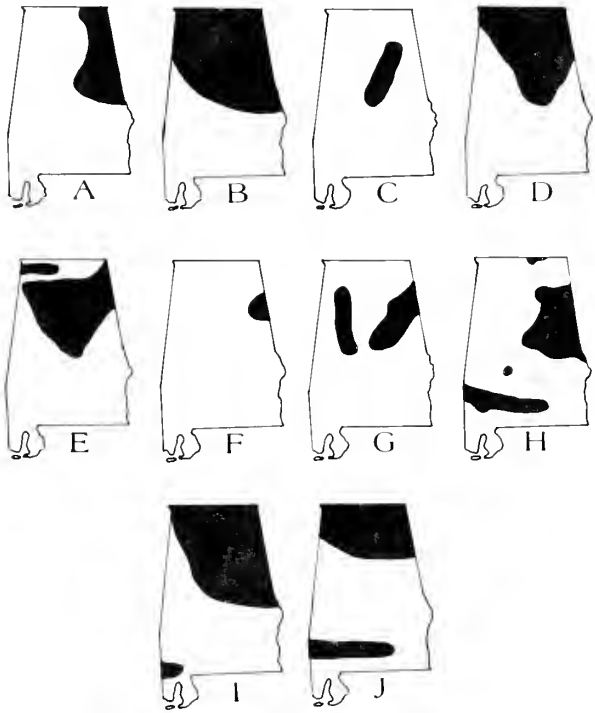

Figure 4. Alabama distributions of *Bufo americanus* (map A), *Pseudacris brachyphona* (map B), *Eurycea aquatica* (map C), *Eurycea lucifuga* (map D), *Gyrinophilus porphyriticus* (map E), *Plethodon cinereus* (map F), *Desmognathus aeneus* (map G), *Desmognathus monticola* (map H), *Plethodon dorsalis* (map I), and *Rana palustris* (map J).

Present knowledge indicates that Coosa Valley populations of *Rana areolata*, *Hyla femoralis*, *Heterodon simus*, and *Micrurus fulvius* are disjunct from Coastal Plain populations (Fig. 5H-K). The presence of these species as disjunct populations seems to indicate that they were once more widespread in northern Alabama, with subsequent environmental changes causing an overall retreat to the Coastal Plain, but leaving relictual populations in refugia above the Fall Line. According to Smith (1957) a post-Wisconsin warm, moist climatic optimum period allowed southern organisms to disperse to more northerly latitudes than at present. The four species under consideration were probably among them.

Species whose ranges in the Coosa Valley are continuous with those in the Coastal Plain of Alabama include *Bufo quercicus*, *Bufo terrestris*, *Hyla*

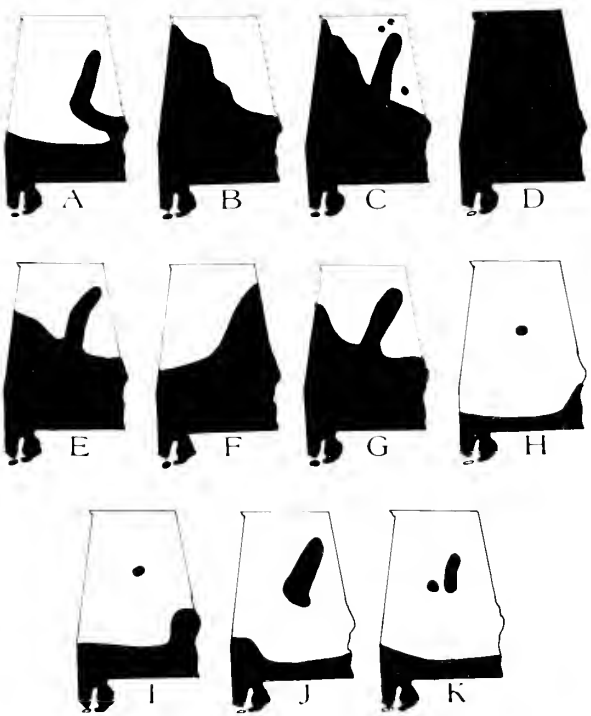

Figure 5. Alabama distributions of *Bufo quercicus* (map A), *Bufo terrestris* (map B), *Hyla cinerea* (map C), *Hyla gratiosa* (map D), *Hyla squirella* (map E), *Ophisaurus ventralis* (map F), *Deirochelys reticularia* (map G), *Rana areolata* (map H), *Hyla femoralis* (map I), *Heterodon simus* (map J), and *Micrurus fulvius* (map K).

cinerea, *Hyla gratiosa*, *Hyla squirella*, *Ophisaurus ventralis*, and *Deirochelys reticularia* (Fig. 5A-G). It could be postulated that the presence of these seven species in the Coosa Valley resulted from recent dispersal northward from the Coastal Plain. However, *H. cinerea*, *H. gratiosa*, and *O. ventralis* exist as apparently localized populations far north of the Fall Line in upland provinces other than the Coosa Valley. Thus, a more appropriate hypothesis would be that most, if not all, of these seven species were more widely distributed in northern Alabama than at present, and that the persistence of populations in the Coosa Valley reflects the persistence of suitable habitats.

Present Environmental Conditions Responsible for Survival of Relictual Species

The most notable characteristic of the herpetofauna of the Coosa Valley is the presence of species that are typically considered Coastal Plain forms. Environmental factors responsible for the continued survival of these relictual populations are not obvious. Much of the Coosa Valley is a relatively old peneplain, with elevations considerably lower than those of surrounding upland provinces. This difference in elevation, however, is not sufficient to produce a noticeably different climate from other regions of Alabama of comparable latitude. When compared to most other terrestrial vertebrates, amphibians and reptiles are relatively less vagile and are probably more limited by substrate characteristics. It is possible that the persistence of relicts in the Coosa Valley reflects favorable soil conditions. The presence in the relatively recent past of longleaf pine flatwoods in the Coosa Valley has already been mentioned. Also of significance is the recent discovery that some soil types in the Coosa Valley are virtually indistinguishable from some in the Lower Coastal Plain of southeastern Alabama. Populations of *Bufo quercicus* in the Coosa Valley are apparently restricted to sandy soil types. In all probability, populations of *Micrurus fulvius* and *Heterodon simus*, which are typically found in areas of loose, sandy soil in the Coastal Plain, are restricted to areas with similar soils in the Coosa Valley. Completion of the soil survey of the district, now underway, and detailed studies of the ecological requirements of the species present, will permit a more detailed correlation of herpetofaunal distribution patterns with soil types than has been possible thus far.

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APPENDIX

Species and Subspecies of Amphibians and Reptiles of the Coosa Valley, Alabama

Class Amphibia
- Order Anura
  - Family Bufonidae
    - *Bufo americanus americanus* - American Toad
    - *Bufo quercicus* - Oak Toad
    - *Bufo terrestris* - Southern Toad
    - *Bufo woodhousei fowleri* - Fowler's Toad
  - Family Hylidae
    - *Acris crepitans crepitans* - Northern Cricket Frog
    - *Acris gryllus gryllus* - Southern Cricket Frog
    - *Hyla versicolor (chrysoscelis?)* - Gray Treefrog
    - *Hyla cinerea cinerea* - Green Treefrog
    - *Hyla crucifer crucifer* - Northern Spring Peeper
    - *Hyla femoralis* - Pine Woods Treefrog
    - *Hyla gratiosa* - Barking Treefrog
    - *Hyla squirella* - Squirrel Treefrog
    - *Pseudacris brachyphona* - Mountain Chorus Frog
    - *Pseudacris triseriata feriarum* - Upland Chorus Frog
  - Family Microhylidae
    - *Gastrophryne carolinensis carolinensis* - Eastern Narrow-mouthed Toad
  - Family Pelobatidae
    - *Scaphiopus holbrooki holbrooki* - Eastern Spadefoot
  - Family Ranidae
    - *Rana areolata sevosa* - Dusky Gopher Frog
    - *Rana catesbeiana* - Bullfrog
    - *Rana clamitans melanota* - Green Frog
    - *R. c. melanota* X *R. c. clamitans* - Green Frog X Bronze Frog
    - *Rana palustris* - Pickerel Frog
    - *Rana pipiens sphenocephala* - Southern Leopard Frog
- Order Urodela
  - Family Ambystomatidae
    - *Ambystoma maculatum* - Spotted Salamander
    - *Ambystoma opacum* - Marbled Salamander
    - *Ambystoma tigrinum tigrinum* - Eastern Tiger Salamander
  - Family Plethodontidae
    - *Desmognathus aeneus* - Seepage Salamander
    - *Desmognathus fuscus fuscus* - Northern Dusky Salamander
    - *Desmognathus monticola* - Appalachian Seal Salamander

Eurycea aquatica - No common name[1]
Eurycea bislineata wilderae X *E. b. cirrigera* - Two-lined Salamander
Eurycea longicauda guttolineata - Three-lined Salamander
E. l. guttolineata X *E. l. longicauda* - Three-lined Salamander X Long-tailed Salamander
Eurycea lucifuga - Cave Salamander
Gyrinophilus porphyriticus porphyriticus X. *G. p. duryi* - Spring Salamander
Hemidactylium scutatum - Four-toed Salamander
Plethodon cinereus polycentratus - Georgia Red-backed Salamander
Plethodon dorsalis dorsalis - Zigzag Salamander
Plethodon glutinosus glutinosus - Slimy Salamander
Pseudotriton ruber ruber - Northern Red Salamander
P. r. ruber X *P. r. vioscai* - Northern Red Salamander X Southern Red Salamander
Pseudotriton montanus flavissimus - Gulf Coast Mud Salamander

Family Proteidae
Necturus beyeri - Waterdog

Family Salamandridae
Notophthalmus viridescens viridescens - Red-spotted Newt
N. v. viridescens X *N. v. louisianensis* - Red-spotted Newt X Central Newt

Class Reptilia
Order Squamata
Suborder Lacertilia
Family Anguidae
Ophisaurus attenuatus longicaudus - Eastern Slender Glass Lizard
Ophisaurus ventralis - Eastern Glass Lizard

Family Iguanidae
Anolis carolinensis carolinensis - Green Anole
Sceloporus undulatus hyacinthinus - Northern Fence Lizard
S. u. hyacinthinus X *S. u. undulatus* - Northern Fence Lizard X Southern Fence Lizard

Family Scincidae
Eumeces anthracinus pluvialis - Southern Coal Skink
Eumeces egregius similis - Northern Mole Skink
Eumeces fasciatus - Five-lined Skink
Eumeces inexpectatus - Southeastern Five-lined Skink
Eumeces laticeps - Broad-headed Skink
Scincella laterale - Ground Skink

Family Teiidae
Cnemidophorus sexlineatus sexlineatus - Six-lined Racerunner

[1]Form of uncertain taxonomic status, closely related to *E. bislineata*.

Suborder Serpentes

Family Colubridae

Carphophis amoenus amoenus - Eastern Worm Snake
Carphophis amoenus helenae - Midwest Worm Snake
C. a. amoenus X *C. a. helenae* - Eastern Worm Snake X Midwest Worm Snake
Cemophora coccinea copei - Northern Scarlet Snake
Coluber constrictor constrictor - Northern Black Racer
C. c. constrictor X *C. c. priapus* - Northern Black Racer X Southern Black Racer
Diadophis punctatus punctatus X *D. p. stictogenys* X *D. p. edwardsi* - Ringneck Snake
Elaphe guttata guttata - Corn Snake
Elaphe obsoleta obsoleta - Black Rat Snake
Elaphe obsoleta spiloides - Gray Rat Snake
E. o. obsoleta X *E. o. spiloides* - Black Rat Snake X Gray Rat Snake
Heterodon platyrhinos - Eastern Hognose Snake
Heterodon simus - Southern Hognose Snake
Lampropeltis calligaster rhombomaculata - Mole Snake
Lampropeltis getulus niger - Black Kingsnake
L. g. niger X *L. g. holbrooki* - Black Kingsnake X Speckled Kingsnake
Lampropeltis triangulum elapsoides - Scarlet Kingsnake
Masticophis flagellum flagellum - Eastern Coachwhip
Natrix erythrogaster flavigaster X *N. e. erythrogaster* - Yellow-bellied Water Snake X Red-bellied Water Snake
Natrix sipedon pleuralis - Midland Water Snake
Opheodrys aestivus - Rough Green Snake
Pituophis melanoleucus melanoleucus - Northern Pine Snake
Regina septemvittata - Queen Snake
Storeria dekayi wrightorum - Midland Brown Snake
Storeria occipitomaculata occipitomaculata - Northern Red-bellied Snake
Tantilla coronata coronata - Southeastern Crowned Snake
Thamnophis sauritis sauritis - Eastern Ribbon Snake
Thamnophis sirtalis sirtalis - Eastern Garter Snake
Virginia valeriae valeriae - Eastern Smooth Earth Snake

Family Elapidae

Micrurus fulvius fulvius - Eastern Coral Snake

Family Viperidae

Agkistrodon contortrix mokeson X *A. c. contortrix* - Northern Copperhead X Southern Copperhead
Agkistrodon piscivorus piscivorus - Eastern Cottonmouth
Crotalus horridus atricaudatus - Canebrake Rattlesnake
Sistrurus miliarius miliarius X *S. m. streckeri* - Carolina Pigmy Rattlesnake X Western Pigmy Rattlesnake

Order Testudinata

Family Chelydridae

Chelydra serpentina serpentina - Snapping Turtle

Macroclemys temmincki - Alligator Snapping Turtle

Family Emydidae

Chrysemys picta marginata X *C. p. picta* - Midland Painted Turtle X Eastern Painted Turtle

Deirochelys reticularia reticularia - Eastern Chicken Turtle

Graptemys pulchra - Alabama Map Turtle

Pseudemys concinna concinna - River Cooter

Pseudemys scripta scripta X *P. s. elegans* - Yellow-bellied Pond Slider X Red-eared Pond Slider

Terrapene carolina carolina - Eastern Box Turtle

T. c. carolina X *T. c. triunguis* - Eastern Box Turtle X Three-toed Box Turtle

Family Kinosternidae

Kinosternon subrubrum subrubrum - Eastern Mud Turtle

Sternotherus minor peltifer - Stripe-necked Musk Turtle

Sternotherus odoratus - Stinkpot

Family Trionychidae

Trionyx spiniferus asper - Gulf Coast Spiny Softshell

EXTENDING STUDENT UNDERSTANDING OF THE LAW OF DIFFRACTION FOR OPTICAL WAVES AND QUANTUM PARTICLES

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ABSTRACT

A simple development of the condition for constructive wave interference for reflected components superimposed *at a given point in space* (*e.g.*, at a detector) is shown to lead to the well-known Bragg Law ($n\lambda = 2d \sin\theta$), where the integer n indexes the order of the reflection. Attention is thereby focused on the response of a detector, which is complementary to the usual development of the Bragg Law based on the condition of phase equality at different points on the planar wavefront of the reflected beam. The simultaneous presentation of both developments provides convincing proof to the student that the reflection of a plane wave of wavelength λ incident at an angle θ with respect to a series of parallel semi-transparent reflection planes having equidistant spacing d yields a reflected wave which has the plane-wave form with the amplitude governed by the constructive interference between all reflected components.

Introduction

It is generally known that there is a coherent scattering of waves in certain spatial directions when an incident wave impinges on a periodic arrangement of scattering centers.[1-4] In the simplest geometry, a plane wave can be considered to be scattered by a set of parallel planes, each plane being partially transparent to the incident wave. The mathematical relation characterizing this coherent scattering is known as the *Bragg condition*[3] or the *Bragg law*,[4]

$$n\lambda = 2d \sin\theta \quad . \quad (n = \text{integer}) \tag{1}$$

As indicated in Fig. 1, the angle θ is that which the line of propagation C_oA_o of the incident plane wave makes with the series of partially reflecting planes separated by equal perpendicular distances d. The symbol λ denotes the wavelength, and n can be any positive integer. The standard derivation yielding Eq. (1) found in many textbooks[3-5] on modern physics and solid state physics is simple, and at the same time, elegant. It is based on the condition that the reflected beam have a planar wavefront, which is assured by requiring that the net phase difference between components reflected from different planes in the series be some integer multiple of 2π at a planar surface perpendicular to the direction of travel of the outgoing wave. This approach is without doubt a powerful tool for convincing the student that wave diffraction can indeed occur. Nevertheless there is at least one major question which is left unanswered by the approach, namely, *are all reflected components superimposed at any given spatial location also in phase?*

This question is very important insofar as detector response is concerned. Components which are out of phase result in destructive interference and hence give rise to a lower power density and a correspondingly low (or null) detector response, whereas in-phase components lead to constructive interference and hence give rise to a corresponding maximum in the detector response. This can be understood from the time average of the square of the electric field amplitude at the detector. The thrust of the present development is to show that the Bragg law is also a sufficient condition for constructive interference between reflected components superimposed at any given point in space, in addition to being the criterion for phase coherence over a reflected planar wavefront. The approach utilized is to derive the condition for such local constructive interference, and the condition thus obtained is observed to be identical to the Bragg condition. The author has found this complementary derivation of the Bragg law to be very useful in developing in-depth student understanding of wave diffraction, and it is in this spirit that he presents it to his teaching colleagues.

Standard Approach Based on Phase Coherence Over the Reflected Wavefront

First of all let us examine a slightly generalized version of the standard development of the Bragg law stated above as Eq. (1). For phase coherence over the planar wavefront of the reflected beam (*cf.* Fig. 1), it is required that the differences in path length traveled by the respective rays 0, 1, 2, 3$\cdots$ be an integral number of wavelengths for the radiation in question. Thus, if the sum of the lengths of the paths F_jA_j and A_jG_j is denoted by $F_jA_jG_j$, it is required that

$$F_jA_jG_j = n_j\lambda \quad , \qquad (2)$$

$$(j=1,2,3,\cdots,\ n_j=\text{integer})$$

where n_j is a positive integer. From the right triangles $A_oF_jA_j$ and $A_oG_jA_j$,

$$F_jA_jG_j = jd \sin\gamma + jd \sin\gamma' \quad . \qquad (3)$$

It can be noted, however, that the angle illustrated as γ is equal to θ, since it is clear that $\theta+\beta=90^o$ and also $\beta+\gamma=90^o$. Similarly, the angle illustrated as γ' is equal to θ'. Since $\theta'=\theta$ (the angle of reflection is equal to the angle of incidence[6] in geometrical optics), it follows that $\beta'=\beta$ and $\gamma'=\gamma$. Therefore Eq. (3) reduces to

$$F_jA_jG_j = 2jd \sin\theta \quad , \qquad (4)$$

and substituting this result into Eq. (2) gives the condition

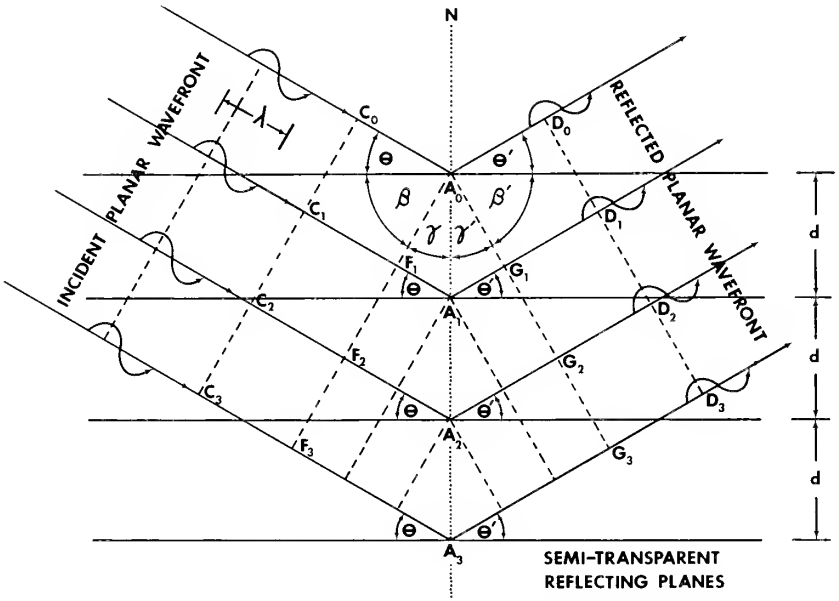

Figure 1 - Cross-section of a set of partially transparent reflecting planes for incident radiation of wavelength λ for deducing the Bragg condition for phase coherence over the reflected wavefront.

$$2jd \sin \theta = n_j \lambda \quad . \tag{5}$$

It is evident that whenever Eq. (5) is satisfied for j=1, with n_j having some integer value $n_1 = n$ (thus yielding phase coherence between waves at the points D_o and D_1), then it will likewise be satisfied for j=2 for the integer $n_2 = 2n$ (thus yielding phase coherence also between the wave at D_2 and the waves at D_o and D_1). In general, then, by choosing $n_j = jn$, Eq. (5) reduces to

$$2d \sin \theta = n\lambda \quad , \quad (n=\text{integer}) \tag{6}$$

which is the Bragg law. Attention is called to the fact that this development is based upon delineating the condition for phase coherence between reflected components at *different* spatial points in the reflected planar wavefront (*e.g.*, at positions D_o, D_1, D_2, D_3, $\cdots$, in Fig. 1). No

information is obtained regarding the phase relationship of the reflected wave components superimposed at any *given* spatial point, such as at D_0, or D_1, or D_2, or D_3, ···, in Fig. 1. This is the focus of the complementary development which follows.

Complementary Approach Based on Phase Coherence at a Given Spatial Location

Let us now consider the superposition of reflected waves at a given point on the reflected wavefront, such as at point D illustrated in Fig. 2. First consider only two rays, such as CAD and EBD in Fig. 2. The path difference between these two rays can be noted to be BA-PA, so the condition for constructive interference of the waves is

$$n\lambda = BA - PA \quad . \quad (n=\text{integer}) \tag{7}$$

If this condition is satisfied, then as will be shown later, the reflected waves from an arbitrary number of such parallel planes will be in phase. We now deduce the expression for BA-PA in terms of the angle θ and the lattice spacing d. The two angles designated ϕ in Fig. 2 are equal because the angle of reflection is equal to the angle of incidence, a well-known law[6] in geometrical optics. The two angles designated θ are equal for the same reason. From the elementary geometry of intersecting straight lines, it can be seen that the angle θ' in Fig. 2 is equal to θ, so the angle labeled ε is given by

$$\varepsilon = \tfrac{1}{2}\pi - 2\theta \quad . \tag{8}$$

Since $\theta''=\theta'$, again a matter of elementary geometry, it follows from the figure that

$$\sin\theta = \sin\theta' = \sin\theta'' = \frac{d}{BA} \quad . \tag{9}$$

Note further that

$$\sin\varepsilon = \frac{PA}{BA} \quad . \tag{10}$$

We thus can utilize (9) and (10) to write

$$BA = \frac{d}{\sin\theta} \tag{11}$$

and

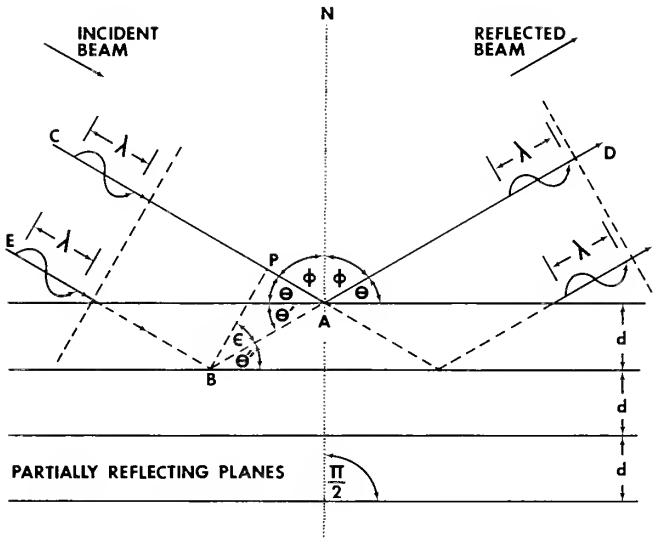

Figure 2 - Geometry for deducing the condition for phase coherence of two reflected components superimposed at a given location in space.

$$PA = BA \sin \varepsilon = \frac{d \sin \varepsilon}{\sin \theta} \quad . \tag{12}$$

Therefore

$$BA - PA = \frac{d(1 - \sin \varepsilon)}{\sin \theta} \quad . \tag{13}$$

Employing (8), we see from trigonometry that

$$\begin{aligned} \sin \varepsilon &= \sin(\tfrac{1}{2}\pi - 2\theta) \\ &= \sin \tfrac{1}{2}\pi \cos 2\theta - \cos \tfrac{1}{2}\pi \sin 2\theta \\ &= \cos 2\theta \\ &= \cos^2\theta - \sin^2\theta \quad . \end{aligned} \tag{14}$$

Substituting into (13) gives

$$BA - PA = \frac{d[(1 - \cos^2\theta) + \sin^2\theta]}{\sin\theta}$$

$$= 2d \sin\theta \quad . \tag{15}$$

Substituting this result into the condition (7) for constructive interference gives the condition

$$n\lambda = 2d \sin\theta \quad , \tag{16}$$

which is identical to the Bragg condition given by Eq. (1).

It is a simple matter to generalize the development to include reflections from the third, fourth, fifth, and other sequential planes. Figure 3 illustrates the geometrical situation for this more general case. The path differences for the various reflected waves which reach D_o are given by $B_jA_o - P_jA_o$, and the condition for constructive interference is that these path differences be equal to an integral number of wavelengths,

$$B_jA_o - P_jA_o = n_j\lambda \quad . \tag{17}$$

$$(j=1,2,3,\cdots,\ n_j=\text{integer})$$

The series of right triangles labeled $B_jA_jA_o$ $(j=1,2,3,\cdots)$ are similar because they have the common angle $B_1A_oA_1$. Since the legs A_jA_o of these right triangles are of length jd, respectively, the hypotenuses are likewise in the same ratio,

$$B_jA_o = jB_1A_o \quad . \tag{18}$$

$$(j=1,2,3,\cdots)$$

However, the series of right triangles labeled $P_jA_oB_j$ $(j=1,2,3\cdots)$ are also similar since the angle $P_1A_oB_1$ is common to all of them. The hypotenuses of this series of right triangles are likewise B_jA_o, which are integer multiples of B_1A_o according to Eq. (18). Therefore the legs P_jA_o of this series of similar triangles are in the same ratio,

$$P_jA_o = jP_1A_o \quad . \tag{19}$$

$$(j=1,2,3\cdots)$$

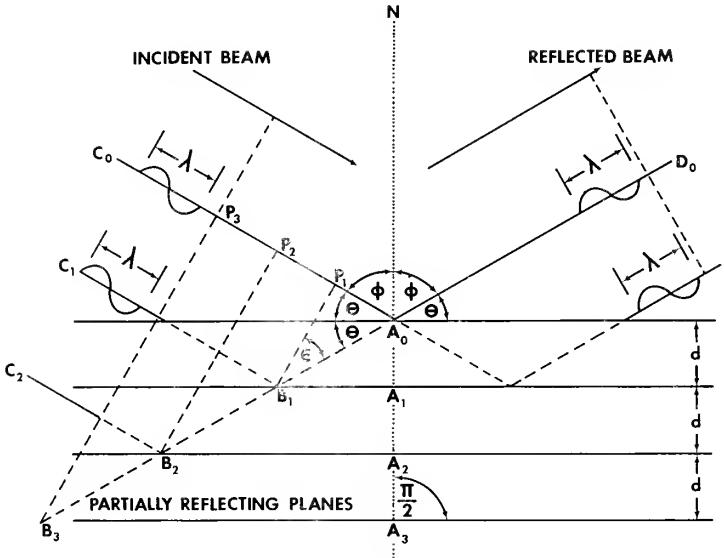

Figure 3 - Generalization of Fig. 2 to include an arbitrary number of reflected components.

Substituting Eqs. (18) and (19) into Eq. (17) gives

$$j(B_1A_0 - P_1A_0) = n_j\lambda \quad . \tag{20}$$

Whenever the Bragg condition is met for the first two reflecting planes, namely

$$B_1A_0 - P_1A_0 = n\lambda \quad , \quad (n=\text{integer}) \tag{21}$$

then direct substitution shows that Eq. (20) is likewise satisfied, since $n_j = jn$ is indeed an integer as required. Thus the Bragg condition is sufficient to insure that all reflected components be in phase at any given spatial point, as for example, at the location of a small detector.

The de Broglie relation[1] $\lambda=h/p$ gives the wavelength λ of matter waves for a beam made up of particles each having momentum p, where h denotes Planck's constant having the value 6.626×10^{-27} erg-sec. The hypothesis made by de Broglie in 1924 that matter has wavelike properties was con-

firmed by the low energy electron diffraction experiments of Davisson and Germer.[2] Accepting this starting point, the diffraction of particles can then be described in the same way as diffraction in classical wave motion, as, for example, electromagnetic waves or sound waves.

Summary

A complementary derivation of the Bragg condition is given which is based on the condition that reflected waves interfere constructively with each other at given positions in space. This contrasts with the usual condition of constant phase for selected points on the planar wave front of the outgoing plane wave. The present derivation is not presented as a substitute for the standard derivation. On the contrary, the insight provided by the standard development should certainly not be minimized, since a uniform phase over a planar wave front is a necessary condition that the outgoing wave be of the plane wave form. The complementary development presented herein does provide additional insight into the problem of understanding the response to be expected from a detector fixed at a given location in space.

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A B S T R A C T S

Papers presented at the 52nd Annual Meeting
Auburn University
Auburn, Alabama
April 3-5, 1975

BIOLOGICAL SCIENCES

STUDIES ON THE EFFECT OF THE CONTACT NEMATICIDE ETHOPROP ON SOIL FUNGI

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Changes in numbers and kinds of fungi in field soil treated with the contact nematicide ethoprop (O-ethyl S, S-dipropyl phosphorodithioate) were determined by dilution plate procedures using a glucose-yeast extract agar medium with sodium propionate and antibiotics (Ohio medium). Plates contained ethoprop in concentrations of 0, 10, 20, 50, 100, 300, 400, 500, or 750 µg/ml of medium. *Aspergillus niger* was unaffected by concentrations of ethoprop in the range of 0-300 µg/ml; colonies in plates with higher concentrations were atypical, fewer in number, and appeared as rugose growth with white conidiophores. Numbers of colonies of *A. flavus* and of *Penicillium* spp. were unaffected by ethoprop concentrations of $\leq$ 100 g/ml, whereas higher concentrations eliminated all colonies of these fungi. Fungi in the order Mucorales (principally *Mucor* sp. and *Rhizopus* sp.) were more sensitive to the nematicide than other species isolated in the plates; no colonies of fungi in this order were observed in plates containing ethoprop at concentrations higher than 50 µg/ml. Numbers of unidentified fungi did not vary significantly with ethoprop treatments of 0-100 µg/ml, but 200-750 µg/ml excluded colonies of these fungi. This study indicates that ethoprop has antifungal properties and that it may exert a degree of selectivity between various species of soil inhabiting saprophytic fungi.

PRELIMINARY STUDIES ON THE ISOLATION AND CHARACTERIZATION OF BOVINE COLON PLASMA MEMBRANE PROTEINS

Jess J. Edwards and George B. Cline
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Bovine colon plasma membranes were isolated in discontinuous sucrose density gradients in the B-XIV zonal rotor by centrifugation for thirty-five minutes at 28,000 rpm. The plasma membrane fractions as determined by 5'nucleotidase activity were collected and then pelleted in a Ti50 angle head rotor by centrifugation at 40,000 rpm for thirty minutes.

Pooled plasma membranes were then divided into two fractions. One fraction was used as an immunogen and injected into a rabbit for the production of an antisera against the plasma membrane components. Antibodies to the membrane components were determined by double diffusion and immuno-electrophoresis.

The remainder of the plasma membranes was treated with a 4% solution of N-lauryl sarcosinate and then centrifuged at 100,000g for one hour. This treatment resulted in 75 to 80% of the membrane protein being solubilized. The soluble fraction was then washed free of N-lauryl sarcosinate and concentrated by ultrafiltration. The soluble proteins were examined by chromatography on a G-200 Sephadex column and by electrophoresis on cellulose acetate and acrylamide gel.

CONTROL OF SOIL-BORNE *ASPERGILLUS FLAVUS* IN PEANUT FIELDS

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Aspergillus flavus is a natural inhabitant of peanut field soils, but the production of aflatoxin in peanut kernels by this organism has necessitated research to control or eliminate it. Research efforts have evaluated both chemical and cultural methods as possible control measures. Results from 1974 indicated that irrigated peanuts had 70-80% less kernel infestation by *A. flavus* than did comparable dry-land grown peanuts. Soil treatment with fungicides showed good short-term control, but rapid reestablishment of high inoculum densities occurred in treated areas. Use of the acaricide Omite as a soil treatment effectively reduced kernel contamination with *A. flavus*. These data indicate a probable vector role for soil mites in the movement of fungal spores, and suggest that *A. flavus* contamination of peanut kernels may be suppressed by irrigation.

THE EFFECT OF SERUM PROTEINS FROM RATS OF VARYING AGES UPON NUCLEAR BOUND ^{3}H-ESTRADIOL CONCENTRATIONS *IN VITRO*

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University of Alabama, Huntsville

Reports indicate that uterotrophic responses in neonatal rats are reduced or absent. Either the uterus is not yet competent to respond or the presence of α-fetoprotein, a high affinity estrogen binding protein in serum, is preventing the localization of effective concentrations of estradiol in responsive tissues. However, no direct evidence for the latter assumption exists. In fact, neonatal administration of small dosages of estradiol acts at the cellular level to alter differentiation of CNS control of gonadotropin release.

Uteri from 21 day old rats were incubated in Eagle's medium containing 10% serum from rats of various ages (1-90 days) and 10^{-8} M ^{3}H-estradiol to ascertain the relationship between serum protein binding and tissue localization of the hormone. Nuclear bound estradiol, cytoplasmic estradiol and protein bound estradiol remaining in the medium were quantified. An inverse relationship existed between protein bound estradiol and nuclear bound estradiol. Serum from rats 30 days or older, when α-fetoprotein is not detectable in blood, produced minimal inhibition of nuclear uptake and maximal total tissue uptake of estradiol.

Different estradiol dosages, based upon the *in vitro* data, were administered to 5, 13 and 21 day old rats. These resulted in approximately equivalent six hour nuclear retention values based upon uterine weight. Additionally, approximately equivalent relative increases in 24 hour uterine wet weight occurred. It is suggested that the unbound fraction of estradiol in blood is the physiologically active form and that α-fetoprotein can modulate estrogen target tissue responsivity in the neonatal rat.

LEVELS OF *CERCOSPORA* STRAINS RESISTANT TO BENOMYL UNDER VARIOUS PEANUT LEAFSPOT FUNGICIDE PROGRAMS

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Auburn, Alabama

Cercospora arachidicola tolerance to benomyl was monitored through the summer of 1974 in an area in which considerable benomyl tolerance was detected in 1973. The following materials were used for leafspot control on the test plots: 1) benomyl, 2) chlorothalonil, 3) benomyl + maneb + oil, and 4) no treatment. Infected leaves were sampled from test plots and conidial transfers made to potato dextrose agar containing 0, 0.5, and 5.0 µg/ml benomyl for observations on germination and growth. The chlorothalonil and check plots produced about 85% benomyl-tolerant isolates early in the season which increased to about 90% in August probably as a result of spore movement from adjacent benomyl

treated areas. From the benomyl and benomyl-maneb-oil plots almost 100% of isolates, obtained after the first leafspot control spray, were tolerant to benomyl. That high level of tolerance was maintained throughout the summer. At harvest, yields reflected leafspot control. Benomyl plots with poor leafspot control because of the high level of tolerance were similar to the check while chlorothalonil plots with good control yielded the highest. Intermediate yields reflecting an intermediate level of leafspot control were obtained from the benomyl-maneb-oil-treated plots.

SYNERGISTIC EFFECTS OF GROWTH HORMONES IN CULTURED PLANT CELLS----AN AUTORADIOGRAPHIC STUDY

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Explant tissues from the secondary phloem of storage roots of carrot (*Daucus carota*) were cultured in basal medium supplemented with various growth promoting factors, e.g. Zeatin, IAA, etc. Multiple cultures (sometimes containing as many as 6 different growth factors in one culture) were set up simultaneously with a different factor containing the ^{3}H label in each culture. Cultures were continued for a maximum of 16 days, of which some were given the ^{3}H factors on the 1st day others on the 8th day. Following collection and preparation for electron microscopy, tissues were coated with a liquid emulsion, allowed to stand for ± 21 days, developed, and studied by electron microscopy.

Distribution of grains and grain counts indicate that the localization and concentration of radioactivity associated with a particular growth factor will vary depending on the presence or absence of other growth factors in the medium, e.g. the localization and concentration of zeatin can vary by as much as 50%, depending on the nature of other regulators present. This variability is predictable from experiment to experiment.

From these observations, it seems that synergism plays an essential role in the localization and translocation of growth factors in cultured cells. This offers some insight into why regulators can cause different effects at different concentrations and why the effects of regulators on cells can vary with age of the cells or plants involved. This work provides a basis for looking at mechanisms of translocation and binding sites of plant growth hormones.

EFFECT OF FOLIAR FUNGICIDES ON KERNEL QUALITY OF FLORUNNER PEANUTS IN ALABAMA

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The effectiveness of foliar fungicides for control of peanut leafspot, caused by *Cercospora arachidicola*, was evaluated in experiments conducted at the Wiregrass Substation near Headland, Al., from 1971-1974. Fungicides were applied at recommended rates by conventional ground sprayer at 14-day intervals. Quality determination of harvested kernels was made using procedures set up by the Federal-State Inspection Service. Plots sprayed with benomyl, chlorothalonil, triphenyl-tin-hydroxide (TPTH) and copper hydroxide showed significant differences among themselves and when compared to the untreated control plot. Plots sprayed with chlorothalonil had higher quality kernels than those from any other fungicide treatment. However, kernels harvested from the untreated control plots were significantly higher in quality than those from the chlorothalonil-treated plots. Kernels harvested from the benomyl and copper hydroxide treatments were only slightly lower in quality than the chlorothalonil treatment. Kernels from the TPTH-treated plots were significantly lower in quality than the other fungicide-treated kernels.

PRESERVATION OF VIABLE GAMETES OF *FUNDULUS HETEROCLITUS*—THE MUMMICHOG

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Fundulus heteroclitus has been selected as a potential test animal for inflight embryology experimentation in space. In order to achieve fertilization in space, fertilizable ova and sperm must be preserved for periods up to seventy-two hours.

Prior to this study the water-hardening process in ova had been prevented by isotonic solutions. However, these eggs were not fertilizable and some would begin to develop by parthenogenesis.

A Ficoll-Dextran-40 solution prevented water-hardening in *Fundulus* eggs for twenty-four hours. This process was prevented for seventy-two

hours by Dextran-40 with Ficoll. A preliminary experiment established that sperm could retain essentially normal motility after 72 hours storage at 0°C in a Ficoll-Dextran-Instant Ocean medium fortified with ATP and succinate.

SOME PYRENOCARPOUS LICHENS FROM ALABAMA

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Knowledge of the lichen flora of Alabama is, like that of the non-lichenized fungi, relatively incomplete. To date, no adequate documentation of the lichens of the state, even of the macrolichens, has been produced. Charles Mohr in his 'Plant Life of Alabama' listed only 198 species and these included 74 recorded by F. S. Earle and C. Baker as part of a biological survey of the state.

A survey of the microlichens with pyrenocarpous fructifications that occur on living trees has been initiated. A number of interesting species have been found including *Anthracothecium libricola* (Fee) Mull.-Arg., *A. thelemorphum* (Tuck.) Zahlbr., *Arthopyrenia fallax* (Nyl.) Arnold, *Pyrenula mamillana* (Ach.) Trev., *Trypethelium scorites* Tuck., and *T. virens* Tuck.

^{55}FE INCORPORATION BY DOMESTIC RABBITS INFECTED WITH *TRICHOSTRONGYLUS AFFINIS*

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An oral inoculum of 500 L_3 larvae of *Trichostrongylus affinis* was administered to domestic rabbits. ^{55}Fe uptake in the whole blood, hemoglobin, and liver and ^{55}Fe excretion via feces of the infected rabbits were measured and compared to the ^{55}Fe uptake in non-infected rabbits. ^{55}Fe uptake in the hemoglobin and liver of the parasitized rabbits was significantly higher when compared to the controls. The ^{55}Fe uptake in whole blood and ^{55}Fe excretion by the infected rabbits was significantly less than in the controls. These results suggest that the parasitized rabbits are assimilating iron at a significantly higher rate than the uninfected rabbits. These results, thus, indicate that the parasitic infection is altering the iron metabolism of the host.

TOXIGENIC FUNGI FROM THE GROCERY STORE

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Forty-five cultures of fungi representing 7 genera and 26 species were isolated from moldy foods from a local supermarket and were tested for toxicity to brine shrimp. Twenty-two isolates were subsequently tested for toxicity to chicken embryos. Fungus isolates determined to be highly toxic in both bioassay systems were *Cladosporium sphaerospermum* from a bakery product, *Fusarium oxysporum* from carrots, *F. solani* from cabbage, *Aspergillus niger* and *Penicillium corylophilum* from bread, *P. cyclopium* and *P. herquei* from corn meal, *P. lanosum* from onions, *P. steckii* from chocolate syrup, *Penicillium* sp. from jelly, and *Rhizopus nigricans* isolates from sweet potato, applesauce, and strawberries. Approximately one-third of the fungal cultures isolated from foods were moderately to highly toxigenic to brine shrimp and chick embryos, and several additional cultures were slightly toxigenic.

CHANGES IN FATTY ACID AND STEROL CONTENT OF DEVELOPING SOYBEAN SEED

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Soybean seed were analyzed at five stages of development for changes in total lipids, lipid phosphorus, fatty acids and sterols. Total lipids had increased to 13% of the seed dry weight 60 days after flowering (DAF), followed by a slight decrease. Lipid phosphorus, used as an index of phospholipid content, reached its highest levels early in seed development (10 DAF) and declined to 0.03% at seed maturity. Total fatty acids increased steadily during development to 10% of the seed dry weight. Highest total sterol levels were found early in seed development (10 DAF) and declined to 0.03% during maturation.

Gas chromatographic (GLC) analysis of the individual fatty acids (as methyl esters) showed a high concentration of saturated fatty acids at 10 DAF, after which time unsaturated fatty acids predominated. The increase in unsaturation was due to a high proportion of linoleic acid which at 100 DAF constituted 56% of the total fatty acids. Oleic and linolenic acids reached their highest levels at 10 DAF and had declined to 18% and 8%, respectively, at maturity.

Major sterols were identified in mature seed by GLC-mass spectrometry as sitosterol (56%), stigmasterol (21%), and campesterol (13%). In addition, cholesterol, and two sterols, tentatively identified as Δ^7-stigmastenol and 24-ethylidene lophenol, were present as minor constituents of the sterol fraction. Little change in the relative proportions of the major individual sterols occurred during seed development.

OBSERVATIONS OF COCCIDIA FROM BATS

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Cecal contents of 2 of 3 eastern pipistrelles, *Pipistrellus subflavus*, from Lion's Den Cave, Clarke County, Alabama, were observed to contain oocysts of one species of *Eimeria*. A review of literature revealed that this study was the first to reveal an *Eimeria* sp. from bats in North America, and the first report of coccidiosis from the genus *Pipistrellus*. The sporulated oocysts had a rough wall and measured a mean of 19.7 X 17 μm. Stieda bodies and substiedal bodies were present in the sporocysts.

BERMUDAGRASS TREMORS IN ALABAMA CATTLE

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In September of 1974, 40 of 45 cattle in a pasture at the Plant Breeding Unit near Tallassee, Alabama were afflicted with a disease that resembled what has been described as bermudagrass tremors or staggers. Once the possibility of pesticides being the cause was ruled out, the probability of induction of fungal toxins warranted immediate investigation. The predominant fungus present has been isolated and identified. Research is currently underway to determine whether this fungus is the toxin producer. Effects of the toxicosis on several animals were documented on the movie film presented here.

THE LIFE HISTORY OF *LONGISTRIATA NOVIBERIAE* DIKMANS, 1935, IN THE DOMESTIC RABBIT

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This study was undertaken to determine the life cycle of *Longistriata noviberiae*, a common intestinal nematode parasite of rabbits. The life cycle was found to be direct, meaning that no intermediate host is necessary to complete the development of the parasite. Two preparasitic molts and two parasitic molts occur. The first stage larvae hatched in 12-16 hours and molted approximately 24 hours later. The second molt occurred 36-48 hours later giving rise to ensheathed, third stage, infective larvae. In domestic rabbits the infective larvae migrated into the stomach mucosa after ingestion. By the third day of the infection, the fourth stage larvae were found in the small intestine. These larvae molted on the fifth day, and mature worms copulated on the seventh day. Eggs were found in the feces of the domestic rabbit on the ninth day. Egg production continued for four months in some rabbits. Infections could not be established in other small laboratory animals.

FUNGI OF ALABAMA III

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Continued collecting of dematiaceous microfungi from graminaceous and other herbaceous substrates obtained in the state has yielded some additional taxa belonging to the hyphomycetes. These include a new genus, *Gonytrichopsis* Morgan-Jones in ed., based on *G. blairii* Morgan-Jones in ed., found on decaying stems of *Rubus* sp. in an aquatic environment near Auburn. The new generic name is derived etymologically from *Gonytrichum* C. G. Nees ex Pers., whose type species, *G. caesium* Nees ex Pers., bears a morphological similarity to the newly-discovered fungus particularly in the arrangement of the conidium bearing cells.

Other fungi of interest include *Cercosporidium galii* (Ell. and Holw.) Deighton, *Curvularia intermedia* Boedijn, *C. lunata* var. *aeria* (Batista, Lima and Vasconcelos) M. B. Ellis, and two species of *Periconia* Tode ex Fr., *P. byssoides* Pers. ex Merat and *P. digitata* (Cooke) Sacc.

AFLATOXIN B_1 TOXICITY TO *PSEUDOMONAS FLUORESCENS* AND *BACILLUS MEGATERIUM* AS AFFECTED BY SODIUM AND POTASSIUM ION CONCENTRATIONS

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Aflatoxin is a fungal metabolite found in foods that is carcinogenic in animals as well as acutely toxic to both animals and certain microorganisms. Research has indicated that sodium and potassium levels might affect the toxicity of aflatoxin. Cultures of *P. fluorescens* and *B. megaterium* were incubated with several levels of aflatoxin B_1 in mineral salts-glucose broth and nutrient broth respectively with varying combinations of sodium and potassium. Experiments indicated that the growth of *P. fluorescens* was inhibited by 80 µg/ml of aflatoxin in high sodium-low potassium broth and only temporarily inhibited in no sodium-high potassium broth. *B. megaterium* was not inhibited by levels as high as 13 µg aflatoxin B_1. In other experiments, the growth of *P. fluorescens* was temporarily inhibited by aflatoxin only in no sodium-high potassium broth. The growth of *B. megaterium* was inhibited by 9-13 µg of aflatoxin B_1 only in low sodium-high potassium broth.

NOTES ON THE OCCURRENCE OF THE GENUS *STENTOR* (PROTOZOA: CILIOPHORA) IN THE STATE OF ALABAMA

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Six species of the Genus *Stentor* are described with descriptions of their habitats as to fresh or estuarine water. The species were collected from Baldwin, Lee, and Mobile Counties, Alabama. The species described were, *Stentor igneus*, *S. introversus*, *S. mülleri*, *S. niger*, *S. polymorphus*, and *S. roeseli*.

ISOLATION AND PATHOGENICITY OF BACTERIA ASSOCIATED WITH *TRICHOPLUSIA NI*

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The bacterial flora associated with the cabbage looper, *Trichoplusia ni*, was investigated with an aim to finding potential biocontrol agents for this insect. Apparently-healthy *T. ni* larvae were collected from a garden plot in Auburn. Gut tracts of the larvae were aseptically removed and triturated in sterile water. Suspensions were streaked onto blood nutrient agar plates and incubated at various temperatures. Five bacterial colonies of differing morphologies were isolated and characterized by standard techniques and criteria.

Gram-positive organisms identified were *Bacillus licheniformis*, *B. cereus*, and *Sarcina lutea; Escherichia freundii* and *Vibrio leonardii* were Gram-negative organisms isolated from the suspensions. Preliminary experiments indicated that *V. leonardii* was moderately pathogenic, causing approximately 45% mortality among *T. ni* larvae.

OBSERVATIONS ON THE FEEDING AND BREEDING OF THE GREATER SIREN, *SIREN LACERTINA*, IN ALABAMA

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From September, 1972, until April, 1975, a study was conducted to determine the annual cycle of reproduction and to obtain information on other aspects of the ecology of the greater siren, *Siren lacertina*, in a pond in southeastern Alabama. The sex ratio in the sample was about two to one, with males predominating. The gonads of both sexes are bilaterally asymmetrical in position and size. Spermatogenesis begins in the fall, and spermatozoa are released from the testes in late winter and

spring. No indications of sperm storage were observed in males or females. Oviposition occurs between late January and early March, as was indicated by studies of the female reproductive tract. One female was found to have 1400 enlarged ovarian follicles. Courtship and mating were not observed, and attempts to find eggs and larvae were unsuccessful.

Food habit studies were inconclusive. Large amounts of filamentous algae and fragments of other plants were found in the alimentary tract. The most important animal components were aquatic insects, crustaceans, gastropods, and pelecypods, and small fish were occasionally found. It thus appears that the siren is opportunistic in its food habits. It is believed that much of the plant material was ingested secondarily; further studies are needed to elucidate this aspect of the animal's life history.

SEROLOGICAL STUDIES WITH SOME INSECT VIRUSES

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Four nuclear polyhedrosis viruses (NPV) of insects were produced in mass quantities to prepare antigens for serological comparisons. The viruses and insects in which they were produced were: *Pseudoplusia* NPV in *Pseudoplusia includens* (soybean looper); *Trichoplusia* singly embedded NPV, *Trichoplusia* multiple embedded NPV, and *Autographa* NPV in *Trichoplusia ni* (cabbage looper). Polyhedral inclusion bodies (PIB) containing the NPV were harvested from infected insects and purified through a series of differential, continuous sucrose density-gradient, and zonal centrifugations. PIB preparations were decontaminated by treatment with 4.0 M urea, 20% sodium dodecyl sulfate, and sonication, repurified by zonal centrifugation, and lyophilized. Purified PIB were treated with a standard Na_2CO_3-NaCl buffer and subjected to chemical and centrifugal fractionations to separate polyhedral protein and free virions. Homogeniety of preparations was monitored by electron microscopy and polyacrylamide gel electrophoresis. Antisera to polyhedral protein and virions of each NPV were produced in rabbits and used in immunoelectrophoresis and immunodiffusion tests for relatedness. Results to date have been inconclusive.

EFFECTS OF BACTERIAL-VIRAL INFECTIONS ON THE CABBAGE LOOPER

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Effects of combined infections by *Bacillus thuringiensis* (BT) and a nuclear polyhedrosis virus (NPV) were determined in laboratory experiments with larvae of the cabbage looper, *Trichoplusia ni*. Mortality curves determined for each pathogen served as bases for the tests. Third instar larvae averaging 15 mg body weight were inoculated by feeding on diet medium containing desired concentrations of the pathogens. BT concentrations ranging from 5 to 30 µg/ml of diet were prepared from a standard containing 18,000 International Potency Units/mg. NPV was bioassayed in a similar manner with virus concentrations ranging from 1×10^5 to 1×10^7 viral polyhedral inclusion bodies/300 ml of diet. $ELD_{10,50}$ and $_{90}$ for each pathogen were determined by probit analysis of 6 bioassays.

Mortality data from larvae exposed to both pathogens simultaneously at low dosages indicated that effects of the combination were additive. Results from experiments in which larvae were stressed by exposure to NPV for 24 to 144 hr prior to exposure to BT also showed that increased mortality was an additive effect of the two pathogens.

IMPROVED METHOD FOR TITERING BACTERIOPHAGE

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Conventional methods of bacteriophage titrations, mainly agar overlay techniques, involve considerable time and equipment. A method has been developed using microtiter apparatus which alleviates many of these difficulties. This method has the advantage of being both rapid and accurate in titering phage by the plaque-assay procedure. Plaque visibility was found to be enhanced by the addition of triphenyltetrazolium chloride solution to the indicator plates.

ULTRASTRUCTURAL ASPECTS OF MICROSCLEROTIAL DEVELOPMENT IN *VERTICILLIUM DAHLIAE*

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Nuclear, mitochondrial and other cellular changes in developing microsclerotia of *Verticillium dahliae* were studied by electron microscopy. Prior to melanization, the cells exhibited an accumulation of lipid bodies and mitochondria with a variety of alterations in membrane organization. The increased abundance of lipid bodies forced nuclei toward the peripheral region of the cells. The nuclear membrane appeared to become discontinuous and failed to exhibit electron staining. In old microsclerotial cells (20 days), material having the same electron staining properties as chromatin was present without evidence of surrounding nuclear envelope. These nuclear changes might be associated with microsclerotial dormancy and heritable changes which occur during formation of haploid variants.

PHOTOINACTIVATION OF NEWCASTLE DISEASE VIRUS BY SINGLET OXYGEN

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The photodynamic action of visible light and sensitizing molecules on biological molecules is well documented. Several investigators have demonstrated that viruses can be photoinactivated by this process. In recent years singlet molecular oxygen has been indicated as a reactive species in the photodynamic reaction. Evidence has accumulated which indicates that singlet oxygen participates in the oxidation of lipids, proteins, and nucleic acids.

In the present experiment, riboflavin was used as the sensitizer in the photodynamic inactivation of Newcastle Disease Virus. Results indicate that the infectivity of the virus is decreased by irradiation of the virus in the presence of riboflavin and oxygen. The hemagglutination titer of the virus was unchanged. Controls without oxygen did not show a significant decrease in infectivity.

THE JACKSONVILLE STATE UNIVERSITY TEACHING HERBARIUM

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Specimens prepared by the Jacksonville State University herbarium are used in a wide variety of biology classes. Special techniques have been devised for uniform collecting, mounting, and laminating of specimens. Laminated duplicate specimens of local plants are made for classes or individual students. They are also placed on reserve in the library on week ends prior to exams. Color 3 x 5 photographs of landscape scenes are added prior to lamination of specimens used by horticulture students. Covers of various colors are used for specimens stored in herbarium cases. Specified cover colors are used for certain kinds of plants such as ferns or trees. Other identifying colors are used for specimens from Florida, Georgia, Mississippi, Tennessee and other states. Most of the herbarium material is from Alabama and neighboring states. However, a wide variety of material is also available from various areas of the United States and foreign countries for junior-senior and graduate courses such as dendrology, plant taxonomy and plant ecology.

EVALUATION OF CALCIUM HYPOCHLORITE AS A SOIL TREATMENT FOR CONTROL OF FUNGAL PATHOGENS

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Calcium hypochlorite was applied to soil in greenhouse pots to study phytotoxicity to black valentine beans (BVB) *(Phaseolus vulgaris)* and to determine its value in reducing inoculum potential of the diseases caused by *Sclerotium rolfsii* and *Rhizoctonia solani* on BVB. Calcium hypochlorite incorporated to soil at rates of 0, 1123, 2246, 3369, 4492, 6739, and 8985 Kg/ha reduced emergence of BVB proportionately to the rate applied so that no plants emerged from soil receiving the highest rate and emergence for soil with the lowest rate was 84%. Numbers of plants surviving to the trifoliate state were only 44% in soils with 449 Kg/ha and 3% for that receiving 1123 Kg/ha. The effect of Ca $(ClO)_2$ in reducing damage to bean hypocotyls by *R. solani* was not significant. Calcium hypochlorite applied to the soil surface at rates of 0, 40, 81, 121, 162, 203, and 324 Kg/ha resulted in no phytotoxicity to BVB at any of the rates. When oat kernels colonized by *S. rolfsii* were applied to the soil surface and treated with Ca $(ClO)_2$, the number of fungal colonies emerging from the kernels was inversely related to the amount of Ca $(ClO)_2$ on the soil so that only 8% of the kernels gave rise to fungal colonies in soil with 324 Kg/ha Ca $(ClO)_2$ and 60%

in soil with 40 Kg/ha. The number of kernels with *S. rolfsii* colonies attacked by fungal antagonists belonging to the genera *Trichoderma* and *Aspergillus* was only 3-4% in control soil; kernels in soil with Ca $(ClO)_2$ concentrations up to 121-162 Kg/ha when the percent attacked was 19-20%. Higher rates of Ca $(ClO)_2$ resulted in reduction of antagonists so that in soil with 324 Kg/ha only 6% of the kernels were attacked. These studies indicate that Ca $(ClO)_2$ is too phytotoxic to be incorporated in soil but that surface applications of this salt offer potential for reducing fungal pathogens such as *S. rolfsii* which are active on the soil surface.

THE SMALL HOME VEGETABLE GARDEN FOR NORTH EAST ALABAMA

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A series of 2 x 2 Kodachrome slides was used to illustrate how the average homeowner in N.E. Alabama could plant a successful backyard vegetable garden.

Emphasis was placed on planting a garden small enough in size to be properly maintained by the homeowner. Recommendations for lime, fertilizer, etc., in preparation of the garden site were given in easy to follow general terms. Planting dates, distances between rows, and cultivation of the various crops was included in the discussion.

A limited number of varieties of some of the most popular vegetables for Early Spring, Spring, and Fall gardens were discussed, and recommendations made which could be easily followed by the first time gardener.

PESTICIDE INFLUENCE ON THE SAPROPHYTIC ACTIVITY OF *RHIZOCTONIA SOLANI* AND POTENTIAL FOR HOST INFECTION

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Effects of the fungicide PCNB (Terraclor) and three herbicides, prometryne (Caparol), fluometuron (Cotoran) and trifluralin (Treflan), on the antagonistic and competitive interactions between the soil-borne plant pathogen, *Rhizoctonia solani*, and other debris-colonizing microorganisms were determined *in vitro*. Growth of the pathogen on Czapek-Dox agar medium was inhibited at all levels of both PCNB and trifluralin tested (2-100 µg/ml). Prometryne and fluometuron at low levels stimulated growth, while higher levels inhibited the fungus.

Sterilized soybean stem sections (7-10 mm in length) were infiltrated with pesticides (2-100 µg/ml) and buried in soil for 4 days, then recovered and *Rhizoctonia* colonization assessed by plating the sections

on streptomycin water agar. *Rhizoctonia* colonized 100% of untreated stems. PCNB treatments of 2 and 10 µg/ml greatly reduced colonization of stem sections, and higher levels of treatment completely excluded the pathogen. Low levels of trifluralin allowed considerable colonization of stems, but higher levels effectively restricted *Rhizoctonia*. Higher percentages of stem sections were colonized in prometryne treatments than in presence of other pesticides; the effect of fluometuron was intermediate. Generally, when colonization by *Rhizoctonia* was restricted, another fungal pathogen, *Pythium* sp., became dominant, particularly in PCNB-treated tissue. High levels of the three herbicides tended to restrict *Pythium*. The predominant saprophytes competing for substrate colonization were species of *Trichoderma*. Contact or toxic zone inhibition of *Rhizoctonia solani* by these fungi in standard antibiosis assay varied with kind and concentration of pesticide in the assay medium.

When pesticide-treated stem pieces, recovered from natural soil, were placed against roots of aseptically grown cotton seedlings, those treated with PCNB caused greatest injury. Considerable damage also occurred with trifluralin- and fluometuron-treated pieces. *Pythium* was predominantly associated with the damaged roots in all treatments.

SOME RARE PLANTS OF ALABAMA AND THEIR PHYTOGEOGRAPHICAL RELATIONSHIPS

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Several distinct types of distribution patterns are illustrated by taxa closely related to the rare species of Alabama. These patterns indicate either former floristic connections of the Southeast with now distant areas or long-range dispersal of seeds. The degrees of evolutionary divergence between 45 rare species of Alabama and their closest disjunct relatives may be proportional to the amount of time elapsed since disjunction occurred. At least five patterns of phytogeographical affinity have been discerned: 1) certain indigenous species or species complexes, such as *Trillium pusillum* and the allied taxa, *T. texanum* and *T. persistens*, evidently without close relatives in widely disjunct areas; 2) Central American-Mexican, indicated by the two varieties of *Leptogramma pilosa*; 3) western North American, illustrated by *Sarracenia* and *Darlingtonia* in the Sarraceniaceae; 4) South American, exemplified by species related to *Croton alabamensis*; and 5) Asian-Japanese, shown by *Croomia* species. Most rare species in Alabama, including the celebrated ones like *Neviusia alabamensis* and *Rhododendron prunifolium*, are members of the first category. The majority of rare species thus appear to have been the products of relatively recent speciation, especially if long range dispersal is discounted as a major factor resulting in present distribution patterns.

ORNAMENTAL PLANTINGS FOR BIRDS IN NORTHEASTERN ALABAMA

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Shrubs, trees, vines, and other ornamentals all serve the various needs of birds. Plants not only attract birds, but also bring beauty to one's property.

Variety should be taken into consideration when planting. Shapes, sizes, and other such factors should be intermingled.

By studying the plants already present, one can bring in a diversity of plant forms, food producers, and shelter plants. Many common shade trees and landscaping shrubs yield little food for birds. In such places one can work in autumn olive *(Elaeagnus)*, honeysuckle *(Lonicera)*, cherry *(Prunus)*, and others. Areas that have only deciduous trees and shrubs can be improved with red cedar *(Juniperus)*, Carolina laurel cherry *(Prunus caroliniana)*, holly *(Ilex)*, and other evergreens.

Plants should be used in such a way that they provide enjoyment for people as well as birds. Place the plants where they can be observed from windows, terraces, etc. Try to choose those known to attract the most birds for maximum enjoyment. If attention is paid to the periods of bloom and availability it is possible to have a succession of floral displays and bird foods throughout the year.

Hedgerows across open fields, either planted or encouraged to come in naturally, furnish a diversity of plant life that adds both numbers and species of birds to one's property. Multiflora rose *(Rosa multiflora)*, osage orange *(Maclura pomifera)*, or Tatarian honeysuckle *(Lonicera tatarica)*, all provide living fences that shelter and feed both birds and wildlife.

Other plants not previously mentioned that are attractive to birds include: firethorn *(Pyracantha)*, sumac *(Rhus)*, heavenly bamboo *(Nandina)*, bittersweet *(Celastrus)*, virginia creeper *(Parthenocissus quinquefolia)*, and all species of oak *(Quercus)*.

A few cultivated plants especially attractive to both man and hummingbirds are: columbine *(Aquilegia)*, trumpet-creeper *(Campsis radicans)*, silktree *(Albizzia julibrissen)*, tuliptree or yellow poplar *(Liriodendron tulipifera)* and morning glory *(Ipomoea* or *Convolvulus)*.

EFFECTS OF SODIUM AZIDE ON SOIL ENZYMATIC ACTIVITIES AND SOIL FUNGI

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Sodium azide (NaN_3), applied preplant to pine seedling nursery beds at rates of 20, 60, and 120 lb/acre under water seal (WS) or plastic seal (PS), was evaluated over a 1-year period for effects on soil fungi and soil enzymatic activities. Generally, populations of fungi were reduced proportionally to the amount of azide added; this effect was observed throughout the year and was most evident in the WS plots. Lowest numbers of fungi were consistently observed in the methyl bromide-treated control plot. Plots treated with NaN_3 at rates of 20 and 60 lb/acre favored subsequent reinfestation of the plots by species of *Trichoderma;* at the 120 lb rate, numbers of *Trichoderma* were less than in the control plots. Numbers of *Penicillium* colonies were generally low throughout the study. Some reduction in enzymatic activities was detected in soil from plots treated with 120 lb NaN_3, but not at lower levels.

NOTEWORTHY WOODY PLANTS OF BALDWIN COUNTY, ALABAMA

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The woody flora of Baldwin County is rich and somewhat unique in the State primarily because of the diversity of habitats available there and because of the relatively mild climate in this region. Recently Clark (1971) prepared an extensive and valuable account of the woody plants of Alabama. He wisely based the county distribution of the 437 taxa treated on specimens actually collected or observed by him, hoping to stimulate more active collecting in the State in order to fill in distributional gaps.

The following taxa not specifically shown by Clark for Baldwin County have been collected there and specimens of them have been placed in our herbarium: Dwarf Palmetto *(Sabal minor);* White Cedar *(Chamaecyparis thyoides); Smilax smallii;* Carolina Willow *(Salix caroliniana);* Pignut Hickory *(Carya glabra);* River Birch *(Betula nigra);* White Oak *(Quercus alba);* Blackjack Oak *(Q. marilandica);* Swamp Chestnut Oak *(Q. michauxii);* Shumard's Red Oak *(Q. shumardii);* American Elm *(Ulmus americana);* Winged Elm *(U. alata);* Bigleaf Magnolia *(Magnolia macrophylla); Sassafras albidum;* Virginia Willow *(Itea virginica);* Sarvice-Berry *(Amelanchier arborea);* Hawthorn *(Crataegus uniflora);* Hog Plum *(Prunus umbellata); Rosa multiflora;* Blackberry *(Rubus argutus); Sorbus arbutifolia;* Honey Locust *(Gleditsia triacanthos); Lespedeza bicolor;* Kudzu *(Pueraria lobata);* Smooth Sumac *(Rhus glabra);* Poison Oak *(Rhus radicans* var. *Toxico-dendron);* Deciduous Holly *(Ilex decidua);* Box-Elder

(Acer negundo); Rattan-Vine *(Berchemia scandens); Ampelopsis cordata;* Virginia Creeper *(Parthenocissus quinquefolia);* Summer Grape *(Vitis aestivalis); Vitis palmata; Gordonia lasianthus; Hypericum suffruticosum;* Cactus *(Opuntia drummondii);* Crape Myrtle *(Lagerstroemia indica);* Flowering Dogwood *(Cornus florida);* Mountain Laurel *(Kalmia latifolia); Leucothoe axillaris;* Fringe Tree *(Chionanthus virginicus);* Green Ash *(Fraxinus pennsylvanica);* Privet *(Ligustrum sinense); Osmanthus americana; Satureja georgiana;* Trumpet Vine *(Campsis radicans).*

IN VITRO STUDIES ON THE NEMATICIDAL PROPERTIES OF THE FUNGICIDE HINOSAN ON FREE LIVING NEMATODES

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The nematicidal properties of the fungicide Hinosan (O,-ethyl-S, S-diphenyl-phosphorodithioate) were studied *in vitro* using 2 cm diam syracuse dishes each containing one ml of emulsified Hinosan and five nematodes. Fungicide concentrations studied were 0, 20, 40, 80, 100, and 200 µg/ml; each concentration was replicated five times in each experiment. After 16 hr of exposure the number of live nematodes of the bacteriophagous species *Pelodera chitwoodi* and *Turbatrix aceti* (vinegar eel) were reduced proportionate to the concentration of Hinosan between 0-80 µg/ml. At this time all nematodes were dead in dishes with 100 and 200 µg/ml Hinosan. The time necessary to attain 100% kill for the lower concentrations of Hinosan was not proportional to the amount of fungicide present in the dish and varied with the species. Thus, while all *P. chitwoodi* exposed to 20 µg/ml of Hinosan were killed after 64 hr, the time required to attain 100% kill for the vinegar eels exposed to this concentration was 88 hours. Predatory mononchoid and dorylaimoid nematodes were more easily killed by the fungicide than were the bacteriophagous species. All mononchoid nematodes exposed to 20 µg/ml Hinosan were killed after only 2 hours exposure and dorylaimoids were killed after 16 hours. These studies demonstrate that the fungicide Hinosan has differing degrees of nematicidal activity depending upon the species.

IN VITRO STUDIES ON THE NEMATICIDAL PROPERTIES OF THE SOIL FUNGICIDE PCNB ON FREE-LIVING NEMATODES

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Effects of the soil fungicide pentachloronitrobenzene (PCNB) upon various species of free-living nematodes were studied *in vitro.* PCNB was incorporated into attapulgite clay granules at the following rates

in percent by weight: 0, 1, 2, 4, 6, 8, 10. Five granules weighing approximately .00276 gm were added to 2 cm diam syracuse dishes containing 1 ml water and five test nematodes. Each PCNB concentration was replicated 4 times. Nematodes tested were *Pelodera chitwoodi*, *Turbatrix aceti*, and predatory nematodes of the dorylaimoid and mononchoid types. Nematodes in dishes containing the higher concentrations of PCNB died sooner and in greater numbers than did those in lower concentrations. Nematodes in control dishes were not visibly affected. Some species of nematodes showed more tolerance to PCNB than did others. Dorylaimoid and mononchoid nematodes were less tolerant than the other nematodes studied; a greater number of these nematodes died in a shorter period of time. *Pelodera chitwoodi*, a saprophagous nematode, proved to be most tolerant to PCNB; a tolerance similar to that of *Pelodera chitwoodi* was observed for *Turbatrix aceti*. Results of this study indicate the soil fungicide PCNB exerts a direct nematicidal effect toward certain nematodes; other species of nematodes are more tolerant of PCNB.

CHEMISTRY

SOLUBILITY RELATIONSHIPS IN LIQUID FERTILIZER SYSTEMS BASED UPON SUPERPHOSPHORIC ACID

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Superphosphoric acid, when ammoniated, has favorable solubility characteristics as a base solution for preparation of liquid fertilizers containing the major plant nutrients, N, P, and K. Grades containing potassium are made by addition of potassium chloride, and, to prepare most of the plant nutrient ratios desired, it is necessary also to supply additional nitrogen (supplementary nitrogen) from a source such as ammonium nitrate, urea, or a mixture of these. In connection with this use of superphosphoric acid, solubility data at 32°F for the system, ammoniated superphosphoric acid (80% polyphosphate level)-urea-potassium chloride, were determined and are presented in the form of a triangular diagram.

The solubility diagram is constructed so that total plant nutrient solubility is shown directly by curved contour lines. Points are indicated for solutions of plant food ratios that are in greatest use in the fertilizer industry. There is provision for the estimation of solubilities for other ratios by interpolation. The present and previous data show that, with use of ammoniated superphosphoric acids, higher grades of nonpotash liquids are possible than in a completely orthophosphate system; the effects of increasing the polyphosphate level from 0 to 45 to 70-80% on grades satisfactory at 32°F are given. The present and previous data show also that the use of urea rather than ammonium nitrate for supplementary nitrogen makes possible higher solubility for some ratios that contain potassium.

THE PHOTOSENSITIZING ACTION OF 2-NAPHTHYLAMINE ON *E. COLI*

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2-naphthylamine is an industrial carcinogen which has been under study since 1930. Biological investigators have tested for tumor incidence caused by injections, oral doses, or vapor inhalation, of the amine and its metabolites.

The phototoxicity of the amine was investigated by conducting binding studies and measuring the energy transferred from the amine to *E. Coli*. The amine is toxic to the bacteria when irradiated with light whose spectral properties are similar to those of sunlight. The toxic effect is directly related to the amount of dissolved oxygen and is almost completely suppressed by the absence of oxygen within the time frame used. Oxygen promotes the binding of the amine to the bacteria even in the dark. Energy transfer is detectable when binding occurs in the light but not detectable when binding occurs in the dark. Dark bound molecules can be irradiated and apparently rebind to the bacteria through a different binding mechanism.

GEOLOGY

GEOLOGY OF THE CARACOLES SN-BI-W DEPOSITS, INQUISIVI PROVINCE, BOLIVIA

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The Caracoles district, located at the southeastern margin of the Tres Cruces Cordillera, presents a classic example of hypothermal tin-bismuth-tungsten vein mineralization related to batholithic margins. Current exploration has developed ore reserves in at least 60 individual veins encompassing eight kilometers of the batholith margin. Planned development will connect the outlying camps of Pacuni and Lucrecia with the tram station at the Argentina mine by a network of centrally located haulage tunnels.

Mineralization is within margins of the Tres Cruces batholith of late Paleozoic age and adjacent, complexily folded, Ordovician and Silurian sedimentary rocks. The batholith is porphyritic granodiorite, becoming variable in composition and exhibiting more mafic phases near its margin. Contact metamorphic effects, primarily silicification and sericitization, are evident in adjacent shales and quartzites for approximately 500 meters from the contact.

Vein systems generally strike perpendicular to the batholith margin. Wall rock alteration by chloritization, sericitization, and tourmalinization is well developed. Vein mineralogy is simple, consisting of chlorite, tourmaline, quartz, fine-grained cassiterite, pyrite, wolframite, bismuthinite and accessory apatite, sphalerite, and ankerite.

Tungsten mineralization is best developed near batholith margins and in the upper portion of vein systems while tin and bismuth exhibit persistence with depth and concentration within the batholithic interior.

ORIGIN OF LOCAL SPILITIC ROCKS WITHIN MAFIC BODIES

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Spilites are sodium-rich basaltic rocks commonly containing the minerals albite, calcite, chlorite, epidote, and calcic pyroxene. The origin of these unusual rocks has been debated for many years and several models have been proposed to account for their high sodium content. Three different occurrences of sodium-rich rocks are present within an olivine diabase sill in central Arizona and their relationships illustrate one way in which spilitic rocks may originate. The three occurrences are: (1) pods and veins of pegmatitic diabase in the upper one-third of the sill, (2) isolated areas of intense deuteric alteration in the lower one-half of the sill, and (3) a six-inch albitite dike exposed slightly below the center of the sill. The albitite dike is composed of albite, calcite, chlorite, and epidote and contains 9.24 per cent Na_2O. The texture strongly suggests that all the minerals crystallized together indicating a fairly low temperature of crystallization. Albite is the low temperature polymorph and the separation of the 131 and $1\bar{3}1$ peaks indicates a temperature of crystallization of approximately 460°C. It is proposed that during the final stages of consolidation a sodium-rich fluid phase separated from the magma. This fluid moved along fractures in the already solid diabase and caused the deuteric alteration and resulting sodium-rich rocks. The albitite dike probably represents material that crystallized directly from the fluid at relatively low temperatures. Field, petrographic, and chemical data are all consistent with this interpretation.

MINERALOGY OF CITRONELLE AND LISBON FORMATION SEDIMENTS AND THEIR SIGNIFICANCE IN THE GENESIS OF HIGH ELEVATION COARSE CLASTICS IN CLARKE AND CHOCTAW COUNTIES

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High elevation coarse clastics in southwestern Alabama, presently mapped as part of the Lisbon Formation, display lithologic characteristics and stratigraphic relationships that are difficult to reconcile with the regional depositional environment of the Lisbon Formation. Though generally considered to be an arenaceous-argillaceous, nearshore facies in Alabama, exposures of the siderolithic-red bed association are found locally mapped as part of the Lisbon. The petrologic and field relationships observed indicate that where this association is present

that an unconformity probably exists. The clay mineralogy of each of the units and the heavy mineral ratios also support the field evidence that an unconformity is present between Lisbon sediments and similar appearing overlying coarse clastics. The overlying materials are likely of late Tertiary or Quaternary age.

MINERALOGY AND TEXTURE OF RESIDUAL LIMESTONE TROPICAL SOILS

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Residual soils of Yucatan and Northern Guatemala are different in both mineralogy and texture, yet have formed from similar montmorillonite and chlorite bearing limestones. The soils in Yucatan tend to be quite thin, rarely exceeding 10 cm., with kaolinite the dominate clay mineral. The textures of the Yucatan soils vary but usually contain a small percentage of sand sized limestone particles. In Northern Guatemala the soils are considerably thicker ranging from 5 to 50 meters and the principle clay mineral is montmorillonite. The texture of the Guatemala soils is much finer and consist largely of silt and clay sized particles. Differences in these soils can be attributed to several factors among which are, water chemistry, relief, permeability, annual rainfall, and position of the water table.

ELECTRICAL RESISTIVITY INVESTIGATION OF CHEWACLA STATE PARK AREA, LEE COUNTY, ALABAMA

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The structural geology of the folded metamorphic sequence in the Chewacla State Park area in Lee County, Alabama is mostly obscured by a thick "blanket" of sands and gravels of probable Cretaceous age. The electrical resistivity method was utilized in an attempt to obtain subsurface geologic data on the structure and elevation of the metamorphic bedrock below. The Wenner electrical sounding method was used and determinations were made at 45 points throughout the study area. From this data, vertical geologic sections were constructed for each station and a contour map of bedrock elevation was plotted. This map was constructed to give information on the deposition of the alluvial sands and gravels as the base-level of the streams in the area were raised due to the northward advance of the sea in Cretaceous time. Interpretation of the resistivity data was hampered by the lack of drill core data with which to correlate the resistivity data as well as the masking effect of the layer of sands and gravels of extremely high resistivity.

DISTRIBUTION OF *OSTREA CRETACEA*, EUTAW FORMATION (UPPER CRETACEOUS), EAST-CENTRAL ALABAMA

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Ostrea cretacea is a small oyster of localized great abundance that is confined to Upper Cretaceous sediments of the Gulf Coastal Plain. Previously reported occurrences are from the Eutaw Formation in Alabama, western Georgia, eastern Mississippi, and from the basal Mooreville Chalk in central Alabama. The area of field investigation extends from Phenix City to Montgomery. Continuous moundlike and bedded concentrations of *Ostrea cretacea* in the Eutaw Formation are traceable in outcrop from near Phenix City in Russell County to the vicinity of Liberty Hill Church in central Macon County, a distance of 45 miles. These fossil concentrations are in the upper half of 225-330 foot thicknesses of the Eutaw Formation. The upper limit of the vertical range of *O. cretacea* coincides with the appearance of non-marine fine-grained clastics in the uppermost Eutaw.

Ostrea cretacea becomes less abundant in western Macon County and eastern Montgomery County. Very few specimens of *O. cretacea* have been found in the fossiliferous easternmost outcrops of the typical Tombigbee sands in the vicinity of Montgomery. The Tombigbee sands represent a high-energy open ocean environment. By contrast, the continuous stretch of *O. cretacea*-bearing sandy muds in east-central Alabama is comparable in length to Mobile Bay or the Mississippi Sound and is suggestive of a large protected body of coastal waters.

CALCAREOUS NANNOPLANKTON FROM THE BOTTOM OF THE GULF OF MEXICO

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The skeletal elements (coccoliths) of calcareous nannoplankton are an important carbonate component of pelagic sediments deposited in the world ocean. An investigation of surficial bottom sediment samples representative of the deep Gulf of Mexico has yielded at least 60 extant coccolith morphotypes. Relative frequency counts made on each of 53 samples indicates *Emiliania huxleyi* is the most ubiquitous coccolithophyte found in the Gulf, singularly comprising over 75 percent of the bottom sediment coccolith thanatocoenose. Other major constituents of the subtropical nannoflora include *Gephyrocapsa oceanica*, *Umbilicosphaera mirabilis*, *Umbellosphaera irregularis*, *Cyclococcolithina leptopora*, *Syracosphaera pulchra*, *Umbellosphaera tenuis*, *Scapholithus fossilis*, *Rhabdosphaera stylifera*, *Discosphaera tubifera*, and *Thoracosphaera heimi*.

The relative frequency of occurrence of each of the eleven common coccolith morphotypes can be related to near-surface water temperatures and salinities as probable environmental controls. The selective preservation of individual morphotypes was biased toward heavier and more

robustly calcified forms. Thus the bottom sediment coccolith assemblages do not completely represent the known living nannoflora from which they were derived but show varying degrees of post-depositional alteration. The geographical location of samples in which coccoliths have undergone the most noticeable dissolution is on the continental slopes and correlates with areas displaying high organic carbon content in the bottom sediments. {Grateful acknowledgement is made to the Lamont-Doherty Geological Observatory (Grant ONR N00014-67-A-0108-004 and NSF-GA-29460) for supplying core materials on which this research was based}.

NOTES ON THE RED MOUNTAIN EXPRESSWAY CUT, BIRMINGHAM

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A number of modifications of the generally accepted section in the Red Mountain Expressway cut seem to be in order. About 20 genera of Middle to Late Canadian megafossils have been found in the supposed Copper Ridge Dolomite. There seems to be no published formation name applicable to these Ordovician dolomites.

Extensive collecting has yielded no Kinderhookian index fossils from the supposed Maury Shale at Birmingham. Pending the discovery of a Kinderhookian fauna locally, this bed should be considered a residuum and excluded from the Maury Shale. The basal 24 feet of the Fort Payne Chert is here removed from that formation and placed in the Ridgetop Shale. Both the lithology and the fauna are typical of the Ridgetop, except for the remarkable occurrence of three species of *Pentremites*, of the *P. conoideus* group.

The sparsely ferruginous sandstone and shale above the Hickory Nut Seam should be correlated to the Brownsport Group in Tennessee, rather than to the Wayne Group, or the Rochester Shale of New York. The Brownsport is said to be of Cayugan age, and the uppermost 40 feet or more of the Red Mountain Formation are of like age. It is also thought that the Irondale and Kidney seams should be considered of Niagaran rather than Medinan age.

MORPHOLOGY AND ANATOMY OF *SALIX FLEXUOSA* NEWBERRY

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The fossil leaf, *Salix flexuosa* Newberry, found in the Eoline Member of the Coker formation, Tuscaloosa Group, Upper Cretaceous of Alabama, is examined with respect to its morphologic and anatomical characteristics to determine those characteristics which would be useful in taxonomic discrimination.

The fossil leaf was found in a lignitic clay lens believed to have been an oxbow lake. The state of preservation of the leaves was such that detailed examinations were possible and every distinguishable characteristic was closely examined. This included such features as: leaf length, leaf width, petiole length, petiole width, veination characteristics, and microscopic slides of the actual preserved cuticle.

These characteristics were examined through a series of histograms, point-plot diagrams, rose diagrams, and diagrams showing relations of means, ranges, and standard deviations of the observed characteristics. The results of this investigation were summarized, and several practical, discriminative characteristics were observed.

CHANGES IN THE LUNAR PERIODICITY AS SHOWN BY MISSISSIPPIAN AGE CORALS

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Daily growth increments on the order of 50 microns are seen on *Amplexizaphrentis pellaensis* a Mississippian coral (325 million years). These increments and banding represent the daily and monthly lunar periodicity, respectively. Using the average count method on the well-preserved specimens, the increments and bands were counted and tabulated. The Middle Mississippian corals indicate that during this time the lunar month was 30.21 days compared to the Devonian's 30.66 (C. R. Scrutton, 1965) and today's 28 (J. W. Wells, 1963). The lunar year during this time was 393 days, compared with 399 in the Devonian (C. R. Scrutton, 1965) and today's 365 (J. W. Wells, 1963). The results is a decrease of 4 days per 50 million years or 2 seconds every 100,000 years. The theory for this decrease is a deceleration of the earth's rotation caused by the friction between the earth's and moon's gravitational fields.

FORESTRY, GEOGRAPHY, AND CONSERVATION

PERCEPTION OF CHOICE AND DECISION-MAKING BEHAVIOR IN AN INDIAN AGRICULTURAL ENVIRONMENT—A GEOGRAPHICAL PERSPECTIVE

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This study is designed to lend insights into certain physical and cultural parameters which influence agricultural decision-making in a selected area of South India. In the determination of specific behavioral responses that are spatially distinct, emphasis is directed toward an understanding of a single environmental factor, the Southwest Monsoon, in combination with a traditional perception of the environment based on astrological interpretations, ancient texts and regional preferences.

Game theory models are utilized to determine whether cropping patterns reflect optimizing behavior, one end of a spectrum or satisficing behavior on the other. Concluding statements illuminate various strategies that farmers could select by taking into account the environmental conditions, choice of crops, irrigated or dry land and fertilizer inputs.

REGISTERED BEEF CATTLE IN THE UNITED STATES: A REGIONAL APPROACH

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Regional variation in the mix of livestock breeds is an important component of the rural landscape, but the regional geography of breeds has not been intensively studied in America. The purebred beef cattle industry began about the year 1880, and today about one million head are registered annually. Seven breeds of cattle dominate the American beef cattle industry: Hereford, Aberdeen-Angus, Polled Hereford, Charolais, Shorthorn, Santa Gertrudis, and Brahman. Registration figures and membership address lists provided by the breed registry associations constitute basic sources of data. These data permit the construction of choropleth maps based on the use of three-digit ZIP-code zones. An accurate determination of the ancestry of crossbred and non-registered cattle does not seem feasible at present, but it is assumed that the distribution of major types of cattle. The formation of livestock breed regions depends on a combination of historical, environmental, economic, and idosyncratic factors.

PLANNED RURAL VILLAGES AND FUTURE LAND USE IN THE LOWER ELK RIVER AREA: THE ELKMONT EXAMPLE

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Conversion of land from rural to urban uses has become a common occurrence throughout the nation. Within the Tennessee Valley, fringe areas of cities as well as rural areas located away from cities are being absorbed by housing developments, shopping plazas, office and industrial parks. Accompanying the conversion is associative problems consisting of housing sprawl, traffic congestion, inadequate open space, and disruption of physical systems.

Planning agencies are seeking regulatory action to quell the adversities of regional change through large lot zoning, extra-territorial zoning, tax abatement, and utility extension. Such actions have recorded little success in negating diseconomies of residential and commercial sprawl. The Elk River Development Association, in conjunction with the

Tennessee Valley Authority, has conceived an alternative to residential sprawl in a three-county area in northern Alabama and southcentral Tennessee. The concept calls for nine residential villages to be constructed to encourage clustering of homes rather than the random scattering as often occurs in a developing region.

The first village, the Elkmont Rural Village, is designed to be a residential area for 3,000 to 4,000 people rather than a self-contained urban complex of homes, businesses, and factories. At present, the Elkmont site is largely in forest and agricultural land use. Funds for the project are being sought from congressional appropriations, private corporations, and HUD's Title VI New Communities Development Act.

The rural villages represent an attempt to demonstrate how development in rural areas can be planned, funded, constructed, and administered as an alternative to unplanned, inefficient sprawl development.

FOREIGN STUDY TOURS: ISSUES IN STUDY AREA SELECTION

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Foreign study tours have been questioned as to their validity in university geography programs. Administrators often view them as expendable; academicians question the eliteist nature of the tours and their oft-time apparent lack of academic purpose. This paper contends that the program if particular attention is given to the selection of the study area.

This paper shows that study area selection can maximize the academic integrity and marketability of a foreign study tour while working within the framework of university regulations.

GROWING TOGETHER: REFORESTATION ON PUBLIC LANDS IN THE DEPARTMENT OF DEFENSE

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and
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The United States Air Force holds approximately nine million acres of public land in trusteeship for the primary mission of national defense. On some installations forest management programs are in progress. An opinion has been expressed that the number and intensity of these forest management programs could well be increased on many portions of these multiple use type lands. The increases to timber supplies and improvements of the forest natured resource base could be quite substantial.

One of many different ways of accomplishing this forest improvement is being done at Eglin AFB, Florida. A joint agreement with the Boy Scouts of America has resulted in 200 acres of public land being set aside for BSA reforestation work and designated as a nature area. Scouters may agree to clear and plant trees and as long as they tend their plots they are free to use the areas for all types of Scout activities. This perpetuating feature should provide worthwhile additions to our timber supplies, meaningful activities for young persons and a store of environmental experience for each generation. It could well be done on public lands nationwide.

PLANNING FOR LAND USE

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The initial premise of this paper is to deemphasize "land use planning" and to substitute "planning for land use." Planning for land use suggests that all have an opportunity to do something constructive for their state and nation. An orderly plan for using land must be developed by concerned citizen groups since planning for land use is a function of people. A second premise of this paper is that planning for the proper use of land is necessary but that the process has become so nebulous and detailed that little of practical significance is being accomplished. Planning for land use at the local and state levels is spawned by fear of federal legislation that will restrict the planning process. A third premise of this paper is that more has been published on planning land use than can be read and used--with few practical results. The final premise of this paper is to outline some of the forces for getting the planning job done. Federal legislation is again on the way that will dictate the planning process to the states. The rampant forces causing the citizens real concern over how private land can be used seem to eminate from federally oriented headquarters.

REGIONS OF GUATEMALA

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Based upon observations during a recent student field trip, Guatemala can be divided into five physical-cultural regions: the Peten, the Caribbean Littoral, the Highlands, the eastern Ridges and Valleys, and the Pacific Slope.

The Peten is part of the limestone Yucatan platform and is covered by dense tropical forest. Prior to 900 AD the Lowland Maya civilization flourished in Peten. The largest known Maya center, Tikal, is now a major tourist attraction. The Peten is a contemporary frontier being occupied by Indian and Ladino subsistence farmers and by ranchers; the region is a source of tropical wood and chicle.

The Caribbean Littoral is a narrow plain with highlands behind; orographic lifting produces heavy rainfall all year. Once a major banana growing district, it is now primarily used by subsistence farmers and fishermen of which the Black Caribs are the dominant group.

The central Highlands, a volcanic region, contains most of the Indians which constitute half of the Guatemalan population. Serious deforestation of the upland coniferous and broadleaf forest and severe erosion in some areas has resulted from poor agricultural and grazing practices. A great variety of agricultural products is derived from the Highlands including bananas, cacao, sugar cane, citrus, coffee, maize, and wheat.

The Pacific Slope is occupied mainly by Ladino, or non-Indian people. It is a piedmont alluvial plain composed of volcanic debris from the Highlands. Beef cattle, coffee, bananas, and cotton are the major products. Cotton is especially important and has recently displaced bananas as the primary crop in some areas.

In the eastern Ridges and Valleys subsistence farming and ranching are dominant occupations of the Ladino population. The major landforms which trend east-west were formed by the collision of the North American and Caribbean plates. The Motagua trench, followed by the Motagua River, is a major routeway that connects the Highlands with the Caribbean.

PHYSICS AND MATHEMATICS

EXTENDING STUDENT UNDERSTANDING OF THE LAW OF DIFFRACTION FOR OPTICAL WAVES AND QUANTUM PARTICLES

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A simple development of the condition for constructive wave interference for reflected components superimposed *at a given point in space* (*e.g.*, at a detector) is shown to lead to the well-known Bragg Law ($n\lambda = 2d \sin\theta$). Attention is thereby focused on the response of a detector, which is complementary to the usual development of the Bragg Law based on the condition of phase equality at different points on the planar wavefront of the reflected beam. The simultaneous presentation of both developments will provide convincing proof to the student that the reflection of an incident plane wave from a series of parallel semi-transparent equidistant reflection planes yields a reflected wave which has the plane-wave form with the amplitude governed by the constructive interferences between all reflected components.

INDUSTRY AND ECONOMICS

THE DEVELOPMENT OF DESIGN FOR INITIAL COMMUNICATIONS FOR FRANCHISORS

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Marketing communication theory dictates that in the absence of personal contact, successful communication is dependent upon the initial image projected by the non-personal message. Numerous studies have indicated that results of business communiques are postively related to the effectiveness of the initial contact. The use of non-personal communication in the contact phase of negotiation in several business areas is a common practice. A prime example being the efforts franchisors have attempted to stimulate interest in their product offering by selective placement of advertisements in investment oriented publications. The advertisements normally invite the prospective entrepeneur to initiate communications. Thus, the true negotiative process originates with the prospect. These requests for information are typically acknowledged by a packet of data supposedly designed to answer the inquiry and stimulate further interest in negotiations.

It is therefore the objective of this study to determine in fact whether or not franchisers are successful in their initial franchise communications.

The basic contention is the information contained within these packages is extremely diverse within the franchise industry. Preliminary analysis supports this hypothesis based on a selected criteria used in evaluating each individual offering.

Since the first impression made on an investor is perhaps the most crucial point in the entire selling process, an expanded study of this type is considered paramount to those concerned.

SERVICE ADVERTISING AND THE INDUSTRIAL LIFE CYCLE

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Advertising education needs to make a clearer distinction between the advertising of services and the advertising of manufactured products. Service advertising offers less tangible and immediate rewards than product advertising. Service advertising has to communicate the abstract rather than the absolute. Services are more diverse and difficult to define than products, and consumer needs more complex and less simple to identify.

The relationship between the manufacturing and service industries in industrial life cycles provides an appropriate framework for the study of service advertising. Major service industries like education, health, communications, and tourism lead the industrial life cycle in today's post-industrial economy. Products are manufactured after services have initiated the new cycle.

Service industries go through two main phases--the manual phase and the mechanized phase. In the manual phase the new industry offers a diversified, personalized "product" to exclusive consumer groups. Advertising's main objectives are to achieve awareness of the new service and to motivate its use. Emotional appeals to secondary motives are appropriate and credible. Specific benefits can be articulated, but contained within no overall theme. Delayed effects require heavy investment.

In the mechanized phase the separate components of the service are rationalized and standardized. The consumer is offered a less differentiated and personalized "product." Advertising can alert users how best to satisfy their regular needs. Separate campaigns can promote each main service to the relevant target segment. Advertising can identify and personalize the service, and highlight its leading attractions.

With continued growth of private and public services the special requirements of service advertising will demand increased study, teaching and research.

TUSCALOOSA RESIDENTS' NEW CAR PURCHASE-CRITERIA: A COMPARISON OF INSHOPPER AND OUTSHOPPER BEHAVIOR

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This study consists of a two-part investigation concerning purchase-criteria and behavior of 1974 new-car buyers residing in Tuscaloosa County, Alabama. Interest was generated for the study because of the current controversy in the legislature concerning the Tuscaloosa County Use Tax which is strongly supported by Tuscaloosa County New-Car Dealers.

Part I of the comparison study concerns dealership choice-criteria and attitudes toward Tuscaloosa New-Car Dealers as perceived by inshoppers and outshoppers. These individuals are defined respectively as Tuscaloosa County residents who purchased new, 1974 automobiles inside and outside of Tuscaloosa County.

Part II of the study involves a comparison between outshoppers' attitudes and Tuscaloosa New-Car Dealers' perceptions of outshoppers' attitudes. The items investigated in Part I were replicated in Part II when questioning the car dealers.

The purpose of the study was three-fold:

1. To determine automobile dealership choice-criteria differences between inshoppers and outshoppers and as perceived by Tuscaloosa dealers.
2. To discern differences in attitudes toward Tuscaloosa dealers as compared to dealers outside of Tuscaloosa County as held by inshoppers and outshoppers and as perceived by Tuscaloosa dealers.
3. To determine the effectiveness of the Tuscaloosa County Use Tax in raising tax revenues for the county and for counteracting outshopping tendencies of Tuscaloosa residents.

Ultimately, the goal of the study is to point out areas of differences in perceptions and choice-criteria among the three groups studied so as to develop specific marketing strategies for effectively reducing outshopper behavior.

TEACHING BY OBJECTIVES (TBO)—AN APPLICATION IN HEALTH ECONOMICS

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The Graduate Program in Hospital and Health Administration (GPHHA) at the University of Alabama in Birmingham (UAB) has very minimal academic course requirements for admission. The search is for above average students who can make a contribution to the field of hospital and health administration. As a result of this policy, students are admitted to our program with a wide variety of backgrounds, especially with regard to such subjects as economics. Students come from such diverse fields of study as music, mathematics, english, engineering, psychology, physiology, biology and business.

The traditional lecture method of instruction in courses such as those devoted to health economics does not seem to meet the needs of students with such varied backgrounds. If the lecture is directed at the most proficient student, a majority of the students are unable to understand the material. Conversely, if the lecture is directed at the least qualified student, a majority of the students are bored with the material. Even if the lecture is directed at the middle segment of the class, there is a substantial number of students who are bored with the material and a substantial number of students who do not understand the material.

To overcome this deficiency of the lecture as applied to health economics, and to best meet the needs of all students, the courses were divided into small units which were called modules. Within each module the learning objectives are clearly defined, the study material by which the student can acquire proficiency in the objectives is established, and students are permitted to go through the modules at a pace suitable to their learning progress.

The initial experiments with the modular approach as applied to health economics and other topic areas resulted in the development of

a major research effort for the Graduate Program in Hospital and Health Administration. A Faculty Research grant from the UAB Graduate School provided interim support for the project. In mid-1974 a three-year, cost-sharing contract was approved by the Bureau of Health Resources Development of the Department of Health, Education, and Welfare. This contract provides for the development of student-paced teaching modules with financial management/health economics being the first priority for development. An example of the modules being developed for health economics is one on input/output analysis which accompanies this presentation.

WEIGHTED ESTIMATORS IN REGRESSION ANALYSIS

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Consider the linear model $y_t = \beta X_t + \gamma Z_t + u_t$, $t = 1,\ldots, T$, where the explanatory variables X_t and Z_t are fixed with mean 0 and the stochastic disturbance u_t satisfies $E[\, u_t \,] = 0 \ \forall t$ and $E[\, u_t u_s \,] = \begin{cases} \sigma^2 & t=s \\ 0 & t \neq s \end{cases}$. The problem is to estimate the coefficient β.

Feldstein has introduced the weighted estimator $WTD(\lambda) = \lambda\hat{\beta} + (1-\lambda)\hat{b}$, where $\hat{\beta}$ is the ordinary least squares (OLS) estimator and $\hat{b}$ is the omitted variable (OV) estimator. He used a computer simulation experiment to show that WTD compares favorably with OLS over the range of $t_\gamma = \dfrac{|\gamma|}{\mathrm{var}(\hat{\gamma})}$ values studied (0.25 to 3.00) and WTD is superior when t_γ is small.

For X and Z highly correlated we introduce the weighted estimator $WPC(\lambda) = \lambda\hat{\beta} + (1-\lambda)b^*$, where b^* is the principal component estimator of β obtained by deleting the component corresponding to the smaller eigenvalue.

First we compare $MSE[\, WPC(\lambda^*) \,]$ with $MSE[\, WTD(\hat{\lambda}) \,]$ where λ^* and $\hat{\lambda}$ are the respective optimal weights. A sample of our results are:

for $r_{XZ} = .98$ and $\sigma^2 = .5$,

$\lvert\beta-\lambda\rvert$	$\frac{MSE[\ WPC(\lambda^*)\ ]}{MSE[\ WTD(\hat{\lambda})\ ]}$
0.0	0.01592
.5	0.15915
1.0	0.46609
1.5	0.76226
2.0	0.98552
2.5	1.14135
3.0	1.24900

We prove that the quotient of the mean square errors is an increasing function of $|\beta-\lambda|$ and show that when $|\beta-\lambda|$ is small, $WPC(\lambda^*)$ is definitely superior to $WTD(\hat{\lambda})$.

Secondly, since the true optimal weights are unknown in real life, we do a computer simulation estimating $\hat{\beta}$, $\hat{b}$, b^* and the optimal weights. We show that the WPC estimator compares favorably to the OLS for all values of t_γ and is superior to the OLS and WTD estimators when either t_γ is larger or when $|\beta-\gamma|$ is small. Now t_γ is proportional to $1/\sigma^2$. Thus in the simulation we see that the two weighted estimators complement each other; WTD being better when σ^2 is large and WPC is better when σ^2 is small or $|\beta-\gamma|$ is small.

THE ECONOMIC IMPACT OF TRAVEL ACTIVITY IN ALABAMA--DEVELOPING ESTIMATES OF SOME SELECTED AGGREGATES

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Perhaps, the most desired, and yet the most elusive statistic relating to travel activity at the state level is the aggregate annual volume of travelers or travel parties to and within the State. Only when such an aggregate is reasonably approximated is it possible to estimate some of the salient aspects of the overall economic impact upon the State's economy. This requires determination of, not only the total travel population, but of the resident and nonresident components as well.

To derive this aggregate through a sample survey alone would appear to be, in most cases, an unrealistic, if not impossible endeavor. However, the need for such a total in order to develop further meaningful aggregates of overall impact is keenly recognized. In the face of a great lack of uniformity in and wide acceptance of methodology in determining a state's total travel population, a particular method has been devised for measuring this flow in the State of Alabama, beginning from a base of the officially reported state lodgings tax and combine

with a number of known measures from reliable secondary sources and sample statistics to deduce the estimate total travel population.

Relating this aggregate to further sample statistics regarding traveler expenditures enables estimates of income generated by travel activity and employment sustained, in an effort to approximate the economic impact of travel activity on the State.

INDUSTRIAL CLASSIFICATION VS FINANCIAL RATIOS AS GROUPING CRITERIA

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The hypothesis to be tested in this paper is that clusters of companies with similar financial ratios are more useful in the investigation of the relationship between money market indices and stock price movements than the use of traditional industry groups. Stock price movements of both traditional industry groups (two digit SIC codes) and clusters are tested against three money market indices (free and excess reserves and the market rate on 90-day Treasury bills) by using spectral analysis. Under certain assumptions, the phase angle between the stock price series and money market index series can be interpreted as a time delay. In this case it will give the lead or lag between the two series in terms of months.

The phase angle for interest rate-vs-stock price and free reserves-vs-stock price was generally too complicated to interpret as a time shift but the phase shift seems to be about the same for both types of groups. The relationship between excess reserves and stock prices for the various groups appears to more closely approximate pure delay. Thus, the phase angles were interpreted as time shifts, and excess reserves were found to lead stock prices by about 3-4 months. Again there appears to be no difference between the two types of groups. Therefore, financial ratios provide no useful information (not already incorporated in industry groupings) concerning the sensitivity of the price of a company's stock to money market indices.

AN EMPIRICAL STUDY OF THE FIRM'S USE OF THE FORWARD EXCHANGE RATES

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The question of whether or not international firms choose to reduce the risk of exchange rate fluctuations through the utilization of the forward currency exchange is analyzed in a comparison of the activity under fixed and floating exchange rate regimes. The study postulates that under floating exchange rates the international firm will become

more active in the forward currency market in an effort to reduce the increased exchange risk. The paper acknowledges the fact that there are very few sources for data concerning forward market operations and consequently develops a framework for analysis that sides heavily on the theoretical.

The forward currency market is a forum where three participants may be discerned: the interest arbitraguers, the speculators, and the hedgers.

The interest arbitraguers' effect on the forward market is classically explained in the theory of forward exchange by the interest-rate-parity theory. In reality, all of the interest rate differential is not accounted for by the theory since speculators and hedgers are also present in the market.

The speculators are assumed to be risk averse and to act in a way as to minimize their potential losses. Since risk is greater under floating exchange rates, the fixed exchange regime will have more speculative activity present. Therefore, the speculators' impact on the forward market should not be as intense under floating exchange rates.

The hedgers' influence on the forward rate remains after the arbitrage and speculative activity is taken into account.

The paper computed interest rate differentials between the U. S. and Great Britain for a fifty week period immediately before the float of the dollar in March, 1973, and immediately following the float. The difference between the interest rate differentials and the cost of forward cover for the latter period was found to be greater which indicates that hedgers were more active in the market under floating exchange rates.

Risks inherent in foreign trade appear to be dealt with under floating exchange rates by international firms through the use of the forward currency market. However, more concise data are needed to determine the numbers of participants that become involved in forward trading and their motives for doing so.

A THEORETICAL AND EMPIRICAL INVESTIGATION INTO CENTRAL BANK CONTROL OF THE NARROWLY DEFINED MONEY STOCK: 1960-1973

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In recent years, a debate has raged in two primary areas of the finance and monetary literature: (1) the familiar arguments of the monetarists and the nonmonetarists over the importance of money and other monetary aggregates in the determination of spending, output, and prices; and (2) the degree of control of the central bank over the money supply and the "proper" definition of the money supply (i.e., M1, M2, or M3). Furthermore, the importance of monetary aggregates for policy-making has been exemplified by a number of researchers. At least partially due to the conclusions reached by these studies, in early 1970

the Federal Reserve System's Open Market Committee instructed the Account Manager to include the M1 money supply as one of its intermediate target variables in conducting monetary policy. Yet, in testing for control over M1 by the central bank, only Meltzer has provided a significant study in which U. S. Treasury deposits at commercial banks are considered.

U. S. Treasury deposits at commercial banks, more commonly known as Treasury tax and loan accounts, are excluded from the definition of the money supply. As individuals and corporations pay Federal taxes or purchase newly issued Treasury securities, their demand and time deposit balances decrease and Treasury deposits increase. Since Treasury deposits are not defined as part of the money stock, private money decreases as Treasury balances increase and increases as Treasury balances decrease, *ceteris paribus*.

The purpose of this paper is to analyze the relationship of Treasury deposits to the control of the M1 money stock by the monetary authorities. The analysis is carried out by first illustrating the arbitrary manner in which Treasury deposits are omitted from the money supply definition. Then within the theoretical framework of monetary multiplier analysis, policy implications are explored. Regressions are estimated to explain the variation in M1. Since these regressions exhibit a high degree of explanatory power, the extrapolative capability of the equations is also examined. Conclusions and implications pertaining to policy matters are given in the last section of the paper.

SCIENCE EDUCATION

CLASSROOM DEMONSTRATION IN CHEMISTRY—FLUORESCENCE

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Fluorescence, an emission of energy by excited molecules, can be a useful demonstration tool in the teaching of science.

A molecule, when absorbing energy in the ultraviolet region, assumes an excited electronic state. It may dissipate this energy by collision, vibration, energy transfer, or by emitting energy, frequently very rapidly and in the visible light spectrum (fluorescence).

Fluorophors absorb broad bands of ultraviolet light but emit one narrow band. Different fluorophors fluoresce at different intensities because they vary in efficiency of fluorescence emission (quantum efficiency). Efficiency is influenced by the solvent environment. The emitted energy is of a lower energy (longer wavelength) than the excitation energy. Fluorescence usually complies with the Beer-Lambert law at very low concentrations but at increasing concentrations fluorescence self quenching occurs and the law is invalid. Fluorescence is not only concentration dependent, but is frequently pH dependent. Molecules may transfer the absorbed energy to another molecule in which case fluorescence is quenched.

PROVIDING MULTISENSORY EXPERIENCES FOR YOUNG CHILDREN

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The activities described in this study were designed and utilized to focus upon multisensory experiences for young children. With the youngest subjects and with those children who had not had extensive opportunity for sensory maturity prior to the experiment, single-sense stimulation was utilized before the multisensory phases were introduced. Eight sensory gateways were involved. Through those gateways, these senses were stimulated: vision, audition, olfaction, gustation, touch, movement, pain, and temperature. The first five of these senses received more attention in the study.

This study was based upon an assumption that readiness for reading, learning, and general intellectual development can significantly and favorably be affected through planned multisensory stimulation. While only a limited amount of information and data has been gained and the immediate results appear positive, additional phases are planned throughout the next several months.

TEACHING BEHAVIOR THE BSCS WAY—HUMAN SCIENCES PROGRAM

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and
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The human sciences program is BSCS' attempt to provide an exciting and interesting approach to learning for the early adolescent student.

The module includes a variety of meaningful student activities to replace the conventional textbook method of teaching behavior.

The module focuses on such themes as variation of behavior, observation of behavior, and evaluation of behavior.

It is a flexible module, which can be followed through directly or interspersed with other learning materials on behavior.

SCIENCE FICTION: A MEDIUM FOR CORRELATING CREATIVE WRITING AND THE STUDY OF SIXTH GRADE SCIENCE

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The study reported by this paper was based upon an assumption that students need a successful reading experience to help them to develop the basic skills and attitudes needed to continually want to read and independently to explore their surroundings. This science-fiction-

centered instructional approach was designed to provide a medium for correlating creative writing and sixth grade science. Science fiction, we confirmed, provides students with interesting and stimulating material through which their skills in acquiring science knowledge, in reading, and in writing can be improved.

This study involved 60 youngsters at Georgetown Elementary School, Columbus, Georgia. Each student had the opportunity to create his own special science fiction story using contemporary phenomena and ideas from the medium presented. The student shared his ideas in prediction, control, and comprehension of science. The class established a schedule, defined goals and created a working pattern for the science fiction writing. The entire group agreed upon empirical measures to follow-up and evaluate their individualized assignment. This strategy was found to be a mutually acceptable way of assessing quality. Among other approaches, the students were involved in relating fiction to science through discussions of popular television programs, recent motion pictures, and current trade books. Each student was afforded a chance to increase his morale and interest in beginning critical judgment of science fiction. Papers were corrected by members of the class (under detailed guidelines) using the class-developed criteria. A culminating feature of the project was to incorporate our stories into a notebook for addition to the school library, where fellow students could check out and enjoy the science fiction creations of each other.

CONCEPT DEVELOPMENT IN ENVIRONMENTAL EDUCATION

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The need for formal environmental education programs designed to build a citizenry capable of identifying environmental problems and motivated to solve these problems has become more and more obvious. Many strategies have been defined and employed, with varying degrees of success in developing such programs. This paper will illustrate a model for environmental education strategies by schools and/or school systems. The paper will also address many of the necessary and elective program components and will suggest methods to consider in overcoming administrative, fiscal and teacher training constraints. The suggested model is based on experimental programs and field application.

A P.S.I. COURSE IN GENERAL SCIENCE AT THE UNIVERSITY OF ALABAMA IN TUSCALOOSA

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The report describes the design and implementation of a general science course for elementary school teachers which utilizes the Personalized System of Instruction, also known as the "Keller Plan".

The P.S.I. approach was first tried with a class of 43 students during the fall term, 1974. Student response, based on an evaluation questionnaire distributed at the end of the term, was overwhelmingly in favor of the approach being used for general science.

Following registration for the current spring term this investigator randomly selected two sections of general science for use in this study. One section of 36 students served as the experimental group for which instruction followed the P.S.I. plan: self-pacing, use of study guides, progress quizzes to insure unit mastery, and use of student proctors. One section of 18 students, serving as the control group, received instruction in a more conventional lecture-discussion-laboratory approach.

The course outline, textbook and content were identical for the two groups. The groups differed only in the instructional approach used.

Both groups were administered a pre-test to measure each student's understanding of science during the first class meeting; a post-test will be administered at the completion of the spring term. The difference between the two scores will be used as an indicator of the amount of learning accomplished. A mean for the difference will be calculated for each group and will be used as an indicator of the success of the two approaches in encouraging learning by individual students.

AN ECOLOGY LAB COURSE BASED ON A DISK PROGRAM LIBRARY

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A library of programs for an IBM 1130 system was prepared and stored on a special disk. An instructional writeup for each program was prepared, and a set of writeups was given to each student along with a supply of forms ruled for 80 numbered columns. After 30 minutes of training for keypunching and closed-shop procedure in the computer center, students were self sufficient regarding data processing. Exercises done included censusing by Lincoln index and catch per unit effort, study of intrapopulation dispersion by the Poisson method, use of life tables, use of T-test, analysis of variance in competition, and principal components factor analysis of physical variables. Two years of experience with this course indicate that students do not need to know how to program or to operate a computer before using it and that the time saved in calculation is well spent on interpretation and reporting of results.

USE OF MATERIALS FROM ONES ENVIRONMENT IN TEACHING ELEMENTARY SCIENCE

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A demonstration of selected materials that children come in contact with everyday which may be used to enhance their understanding of the basic concepts of teaching science.

Included are demonstrations of activities which may be used to teach some basic concepts in the area of air and weather. The building and use of concept boxes are an important part of this presentation.

TOUCH: A MOTIVATIONAL TOOL FOR SENIOR HIGH SCIENCE

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Touch is such a personal sense that it should have a vital role in the learning process, especially in the area of biology. The experimentation was done with 10th grade biology students over a school year period.

The tactual sense was first used as a tool in the out-of-doors in an effort to motivate an interest in plant life and show its relationship with the total environment. Students were blind folded and led through the woods touching and learning various species of plants.

Since the learning process was so highly enhanced by the use of touch with plants, the touch techniques were used with various animal species and models. Students did achieve at a higher rate in the class using this method, and it is believed that retention rate will also be very noticeable.

SUCCESS STRATEGIES FOR TEACHING SCIENCE IN THE ELEMENTARY SCHOOL

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This study is a description of an attempt to implement the "schools without failure" and "reality therapy" concepts of Dr. William Glasser, California psychiatrist, with a class of twenty-five third grade students at Clubview Elementary School, Columbus, Georgia. The program was generated in a graduate course utilizing educational television offered

by Columbus College and sponsored and coordinated by the University of Georgia in cooperation with statewide staff development program of the Georgia State Department of Education. The program involved the use of "class meetings" in developing and expanding science concepts and communication skills. The concepts of "reality therapy" were used in classroom management and in changing and improving student behavior. While no statistical study of student achievement has been made as yet subjective responses from both teachers and students indicate that the program has been successful overall and that further experimentation and utilization of the program is justified.

SOCIAL SCIENCES

EARLY PROBLEMS WITH AMERICAN--GUATEMALAN TRADE RELATIONS: 1890-1910

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American-Guatemalan trade relations from 1890 to 1910 was seriously affected by three basic factors. Our trade was severely handicapped by competition with European countries that had already established trade relations in Guatemala, the lack of experience in production, distribution and salesmanship on the part of Americans attempting to trade in the country and the inability of the American merchant marine to equal the state supported merchant marines in Europe in low-cost ocean transportation.

There was also no modern transportation link from the Atlantic port of El Rancho to Guatemala City, the principal city of the country, until 1908. In 1908 the Atlantic coast port of Puerto Barrios was connected to the interior upon the completion of the Interoceanic Railway of Guatemala from Guatemala City to Puerto Barrios. Now for the first time

the Gulf ports of New Orleans, Mobile and Tampa could attempt to make the most of their geographical advantages of direct Gulf service to Guatemala.

LIFE IN SPANISH FLORIDA AT THE CLOSE OF THE EIGHTEENTH CENTURY

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At the close of the eighteenth century, Spanish Florida was an isolated outpost situated between the Gulf of Mexico to the south and the United States to the north. For some time the Americans had had ambitions to take Florida and they often intrigued against the Spanish colony. Almost as aggressive were the Indians who lived in Georgia and what is now the state of Alabama. The lonely Spanish outposts seem to have been rather unhappy places; there was much friction among the soldiery, occasional cases of insanity and also violence and some homicide. According to one officer, the troops stationed in Florida were not of good quality and desertion was common throughout the province. Florida was a slave territory and its society suffered from all the drawbacks of that institution. Runaway slaves were common and they often escaped north into the Indian nations where they were usually sheltered and sometimes adopted into the tribes. Although these Indians were nominally allied to Spain, they continued to cause trouble in Florida, stealing horses and slaves and killing cattle. One of the reasons for their hostility to Spanish settlements was that Americans often established themselves there and the Indians thoroughly disliked the Americans' penchant for encroaching on their land. The wars in Europe at the time had repercussions in Florida; the coast was constantly menaced by British or French privateers. The paper closes with an unusual account of marital infidelity, involving the commandant at Mobile. Life in Florida in those days was hard and dangerous, but it could hardly be said to have been dull.

THE MOBILE GAZETTE AND THE AMERICAN OCCUPATION OF MOBILE IN 1813: A LESSON IN HISTORICAL DETECTIVE WORK

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The actual date of publication for the first issue of the Mobile *Gazette* has been shrouded in mystery, as noted by Clarence S. Brigham in his *History and Bibliography of American Newspapers, 1690-1820*. In doing research on the 1813 fall of Mobile to American forces under the command of General James Wilkinson, however, this writer discovered a Spanish translation of an article concerning the campaign, which gives April 28, 1813, for the first issue of the *Gazette*. In the State Department of Archives and History, Jackson, Mississippi, a microfilm copy of the *Washington Republican* (Natchez), Vol. I, No. 8 (June 1, 1813), gives

a similar account, based on the April 28 issue of the Mobile *Gazette*. By comparing the stylistic variations of the two accounts, it is possible to trace the movements of the American expedition from New Orleans to Mobile Bay. The two accounts are not identical, however, and it is possible that both were based on Spanish translations from the original *Gazette* item. American frontier expansion into West Florida was a popular step during the War of 1812, and this account sheds humorous sidelights on previous accounts by Isaac Joslin Cox and Peter J. Hamilton.

SHIPS AND EMPIRE: THE CASE OF SPAIN

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Of all the great European rivals for maritime and naval supremacy of the seas in the sixteenth and seventeenth centuries probably less is known in English of Spanish ships and shipbuilders than of the French, Dutch, or even Scandanavian competitors. The oversight or scantiness of knowledge is particularly glaring for the sixteenth century when Spain exerted a most impressive hegemony over Europe and the world and her naval and maritime fleets contributed a great deal in this period of predominance. Nonetheless, while the sixteenth century exemplified an era of almost unparalleled success, the seventeenth was accompanied by entrenchment, rigidity, and finally, decline.

A substantial renaissance of the Spanish shipyards occurred under the Bourbon kings in the following century. More efficient French administrative procedures were introduced, English master craftsmen were brought in to modernize shipbuilding along more scientific lines, and the shipyards of the colonies, principally those at Havana, were stimulated to even greater productivity. However Spain's rivals for power in Europe and empire in the world, principally England, France, and Holland, had not lagged in the crucial seventeenth century and the low fortunes of the Spanish shipbuilding industry in that era helped precipitate her decline from unchallenged supremacy that she had held at the beginning of the early modern period.

This paper is a short overview of the interaction of those naval and maritime elements that contributed to Spain's rise and fall in the sixteenth and seventeenth centuries as described above. It is a sketch of a subject that might profitably be expanded into a much larger and more meaningful exploration of the dynamics of the Spanish Empire.

PHYSICIANS, MEDICINE, AND HEALTH OF ANTE-BELLUM MOBILE

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Mobile in the ante-bellum years of 1820-1860 was a developing commercial city made prosperous as the second leading port for the exporting of cotton in the United States. To perform and service the numerous

commercial functions, the composition of the population was quite diverse in nativity and status with relative equal numbers of people of Northern, Southern and foreign birth. The 1860 population of just over 29,000 consisted of 20,854 whites, 817 free colored, and 7,587 slaves. There also was a large transient population of young white males who worked as mechanics, clerks and laborers.

This paper is an effort to describe the health concerns of the people and the city, and what facilities, programs, and physicians the city had to meet those needs. The low elevation of the city with many marshes in the area appeared to the nineteenth century observer to contribute to unhealthfulness, and the leading cause of death for the races was consumption with internal disorders such as diarrhea and dysentary quite common. Still births generally occurred equally in proportion to both races, and this would indicate the colored and white population received somewhat equal health care. Yellow fever epidemics periodically devastated the city with the 1853 epidemic being the greatest with 764 deaths.

By the 1850's there were approximately 35-40 recognized physicians in the city, one city-owned hospital, a United States Marine Hospital, the State Medical College, and at least three private infirmaries. In addition there was an active Board of Health and Medical Society. All of these groups cooperated to improve the health of the city, with certain doctors, such as Josiah Nott becoming nationally known. Mobile in the ante-bellum years, in the area of medical and health concerns, was rapidly developing to meet the health problems of its citizens and need not feel inferior to any city in its efforts.

A BRIEF SKETCH OF THE LIFE AND USEFULNESS OF THE REVEREND DR. BENJAMIN TRUMBULL

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The life of Benjamin Trumbull is in many ways almost a textbook illustration of the career of a typical New England minister of the mid-1700's. His life span, from 1735 to 1820, coincided with major events both national and local. The main pursuits of his life, spent almost wholly in his parish of North Haven, Connecticut, were preaching the gospel and writing history, but his reputation is based rather on his secular than his sacred work. A more critical era than his own may well refuse Trumbull the appellation of a "great historian", while still recognizing the value of his research and writings. His life was one of amazing versatility: minister, theologian, farmer, historian, amateur soldier, officer of societies, writer on religion and history, family man, interested citizen. He lived through personal tragedy and national crises without losing his sense of purpose or his enthusiasm. A practical and talented man with a forceful personality, he spent a useful life striving for spiritual sanctity, always acutely conscious of his responsibilities to God, to his flock, to the souls of all men, and to posterity.

Trumbull's example may not serve as inspiration for the present times; some of his most closely-held beliefs may well provoke dissent even among the most conservative in religion and politics. In his life, however, may be traced the course of issues and controversies that shook and shaped his state, his region, and his nation; and not even the most sophisticated cynic can fail to grant the North Haven pastor his meed of respect and admiration.

THE *CAROLINE* AFFAIR

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Late in 1837, during the Canadian rebellions against the British Crown, there occurred one of the most potentially explosive events in Anglo-American relations since the War of 1812. The *Caroline*, a privately owned American steamboat whose owner was accused of giving illicit aid to the insurgents, was captured, burned, and sunk near Niagara Falls by Canadians under command of the British at nearby Chippewa. In the melee, one American was killed. New Yorkers demanded war with England. The event, they exclaimed, had violated national honor. More important, it had been perpetrated by the mother country, which, according to many Americans, hesitated to recognize the United States as fully sovereign. It was the diplomats' responsibility to prevent this inflammatory incident from developing into a third Anglo-American war.

If the governments in London and Washington had not insisted on peace in early 1838, it seems possible that the *Caroline* affair could have combined with the northeastern boundary problem and other Anglo-American differences to embroil the nations in war. The basic issues over national honor were present, just as they had been prior to the War of 1812. The difference was that in the 1830s both sides acted wisely. By a series of diplomatic exchanges, they averted a confrontation by dragging out the argument until emotions had subsided. Then, in 1842, a special minister from Britain, Lord Ashburton, met in Washington with Secretary of State Daniel Webster to work out an informal arrangement which finally closed the *Caroline* affair. It was no small accomplishment that the two nations' diplomatic corps had preserved the peace.

THE UNITED STATES TRADE UNION MOVEMENT: ITS IMPACT ON RECENT AMERICAN FOREIGN POLICY

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Labor's current and past influence on United States foreign policy output is considered. Evidence suggests that the labor movement has generally supported the Administration's position in foreign policy whether that Administration be Democratic or Republican. Doubt is expressed that labor is able to change the direction of foreign policy,

but it is most effective when its views coincide with other groups. Facts support the view that labor leadership does not exert direct influence over the rank-and-file members. Labor leaders simply are unable to deliver the labor vote. One of the problems is the lack of knowledge or concern of a large segment for foreign policy.

One reason that labor leaders have a rather limited effect on the views of the rank-and-file is the fact that union members consider themselves, not primarily as members of unions, but of potentially conflicting identifications. Apathy on the part of many members is an additional factor making it difficult for union leaders to influence the rank-and-file on foreign policy issues. One should not forget, however, that in spite of a direct linkage between union leadership and the rank-and-file, labor leaders can become effective lobbyists since Congressmen and the President may assume that the rank-and-file represent a deliverable vote.

AFRICAN POLITICAL SYSTEM

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The main objective of this paper is to review the background and rise of the single political party, the role of the military in contemporary Africa and the conditions which brought about the present changes.

The nationalist political parties were organized with a tightly disciplined type of leadership by the nationalist leaders responsible for the independence of the African states. Faced with such popular action and mass public opinion favoring independence, the colonial powers could do little but attempt to slow down through constitutional negotiations, the transfer of power. Swept into power at elections prior to independence (Ghana in 1957 was the first) on a wave of almost total popular approval, there was no place for an opposition party nor was there a need for opposition.

Powerful nationalist parties took over power of government from the colonial authorities remained predominant forces in the new African states for almost a decade after independence. Even following their decline, the leaders refused the risk of being turned out of office through the electoral process. In no African state has the party in power been replaced through open elections by an opposition party.

The single party system was regarded by some African leaders as the most effective instrument in coping with the problems of government of the underdeveloped nation. In fact, nation-building was the basic problem of the new states and virtually identified with the broader problem of modernization. The task of integration and representation were the most difficult problems facing them. Instead of promoting political stability, the single party, allegedly did precisely the reverse. So in such a situation, the only way to change power was by means of a coup d'etat.

In late 1965 and early 1966, the political situation underwent a radical change as a result of a series of military coups, in Africa. Seizing power from the civilian heads of states, the military ousted the

political leaders and dissolved the political parties, which formed the basis of the leaders' support.

The coups were the direct result of mass frustration felt by the people as well as the failure of the civilian regimes to fulfill their rising expectations for a better life, after independence.

The military regimes in Africa are not totalitarian simply because they are unable to intervene in the lives of their citizens in an all-embracing manner which the term "totalitarianism" suggests. These regimes do not fulfill three of the six characteristics one may ascribe to totalitarian dictatorships. A central control and direction of the entire economy or a widespread system of terroristic police control are absent, nor do they have an official totalitarian ideology.

A military tradition is lacking in Africa. While the military exercises political control, civilians run the bureaucracies and occupy positions in the cabinets.

The African states have shown that they can govern and, in so performing, have contradicted the predictions of the Europeans who claimed they were incapable of governing themselves.

WILLIAM LEE: LONDON MERCHANT AND PUBLIC OFFICIAL

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William Lee, younger brother of Richard Henry Lee, was one of four brothers intimately connected with the movement for American independence.

Born in Virginia in 1739 at Stratford Hall, he lived his early years as the son of a prominent planter family. In 1768, however, he went to England where he shortly became a tobacco merchant in the American trade, doing most of his business on the Potomac and Rappahanock Rivers. From small beginnings his business grew rapidly and by early 1773 he was publicly acknowledged as a substantial citizen and prosperous merchant. In carrying on his business he performed many different kinds of services for his correspondents in Virginia and Maryland.

For reasons which are not yet clear, he rose rapidly in London politics and held two elective offices. In 1773 he was elected sheriff of the city and two years later an alderman, representing Aldgate ward. In each election he won by a comfortable majority. Instead of being officer-in-name-only, as was common in the eighteenth century, he was an active, even reforming, sheriff and a faithful member of the Court of Aldermen until his appointment by the Continental Congress to a post as commercial agent in France took him out of England. This was mid-1777 but he did not resign his place as alderman until 1780.

The paper raises a number of questions about Lee and his rise to prominence, the role of John Wilkes and of a pro-American pressure group made up of both Americans in London and Englishmen known as the Bill of Rights Society.

The study of Lee, which is still in the research stage, is many faceted, involving economics, politics and diplomacy and reaching from Virginia and England to the Continent.

CLIO PIQUED: CARTOONISTS REPORT THE WATERGATE SCANDAL

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One of the happier results of the scandals of the Nixon administration—known collectively as the Watergate scandal—has been the reinvigoration of political cartoonists. Political cartoons have long been a vital force in American history. Thomas Nast's cartoons were influential in the downfall of "Boss" Tweed, head of a corrupt ring in New York city, during the 1870's. The sixty two cartoons used to illustrate the lecture were copies (on 35mm slides) from American and foreign magazines. Many of the cartoonists proved to be remarkably prescient in assessing the eventual impact of Watergate on the Nixon presidency. One 1972 cartoon pictured Nixon adrift in a small boat and menaced by a small shark (marked Vietnam) and a large whale (marked Watergate). One 1972 American cartoon had one character saying to another at a bar: "Look Nixon's no dope. If the people really *wanted* moral leadership, he'd given them moral leadership." One 1973 cartoon depicted prophetically the light at the end of the Watergate tunnel as a jail cell door.

Virtually every cartoonist was hostile to the Nixon administration and its supporters——regrettably few political cartoonists are basically conservative.

SOCIOLOGY AND DEMOGRAPHIC CONSCIOUSNESS

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Increasingly people throughout the world are developing a demographic consciousness where they incorporate demographic elements in their thinking about individual and collective affairs. Notable for our time is the concern with continued population growth and anticipations of troubled times ahead due to the numbers, present and anticipated, of people and their impact on our ecosystem. Profound issues are involved, our knowledge bearing on them is often imprecise or non-existent, consequently many perplexing situations confront us as we are presented with optimistic and pessimistic appraisals of the human condition. Sociology has had and continues to have a role to perform in the consideration of these population-related discussions. Sociologists, it is proposed, might provide some help in this area of concern by investigating further the importance of numbers in the development of the distinctive Western mode of human living which has come to dominate virtually the whole of human sociocultural existence. In addition, to contribute further to the present confusion of the population debate, the sociologist might venture into the area of attempting to determine the number of people supportable in this world, in a manner that they find acceptable, with the distinctive interactional patterns and structural features characteristic of the West.

SURVEY OF KINDERGARTEN PHILOSOPHIES AND PRACTICES

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A survey of kindergarten philosophies and practices was made in 1974. Throughout Alabama, 441 teachers and directors of three, four, and five year old children responded to the questionnaire.

An effort was made to determine if teachers of young children were more child developmentally oriented or more educationally oriented in their viewpoints. Teachers of church-related, private, Head Start, Title I, public and other types of kindergartens (especially funded kindergartens) were involved.

An instrument was devised on which teachers' responses on each question could be given a numerical value of one to four, with low scores indicating "educational" practices and high scores reflecting "developmental." The least possible total score on the entire instrument was 35 with 140 being the highest possible.

Actual scores ranged from 44.0 to 94.0 with a mean of 75.5. With these scores to serve as norms, it is hoped that teachers can now rate their own practice on an educational-developmental scale.

By groups, Headstart Teachers appeared to have the strongest developmental orientation, with a mean score of 77.5. Title I Teachers were the most educational in their practices, with a mean score of 71.5.

A comparison of the 50 most educationally oriented respondees with the 50 most developmentally oriented revealed the following:

A much greater proportion of teachers of 3 and 4 year-olds were in the developmental group, with more teachers of 5-year-olds in the educational.

The number of years college training seemed to make no appreciable difference in the philosophy and practices of the teachers. Experience seemed to be a factor, with the "educational" group having more experienced kindergarten teachers and the "developmental" group having more with experience in nursery schools and day care centers.

The college major appeared to exert an influence, with more elementary education majors in the educational group and more home economics and child development majors in the developmental.

BLACK NON-AGRICULTURAL LABOR IN ALABAMA, 1865-1880

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In 1860, Alabama's economy was almost totally agricultural and by 1880 the state's economic characteristics remained generally the same. Yet during this period, the initiation of industrialization and the tren toward urbanization which accompanied the reconstruction process afforded some freedmen new job opportunities and increased access to non-agricultural occupations.

Most blacks, as slaves, had been agricultural workers and, as freedmen, most were employed in the same capacity. But during the immediate post-war years former bondsmen tended to leave plantations and rural Alabama and migrate to towns seeking non-agricultural job opportunity and in some instances employment in the developing railroad, coal and iron, lumber, and turpentine industries.

By 1880, freedmen employed as non-agricultural workers generally held jobs which had been rejected by whites. Black artisans and those employed in skilled capacities met strong oppositions. The freedmen's access to industrial occupations depended upon the type of work and the industry. Whites flocked to the less arduous jobs in the textile mills and demanded that freedmen be excluded. But the occupations of railroad laborers, turpentine hands, woodcutters, and coal and iron industrial workers were associated with manual labor. Such occupations were held by blacks and eschewed by whites until persistent economic problems in Alabama prompted despairing whites to pursue almost any available non-agriculture jobs. This condition resulted in increased hardships for the black worker and relegation of many to employment as agricultural field hands.

MULTICULTURAL EDUCATION

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America is a culturally diverse society and every school in our nation has an imperative mission these days: to assist its students for life in a society composed of disparate cultures, racial and ethnic strands.

The prime focus of this discussion will support the concept that there is "No One Model American" and establishes some validity that will prove the "melting pot" theory to be a quaint myth. Emphasis has been given to the "salad bowl" concept in teaching and learning about various cultural groups. The "salad bowl" concept is based on the fact that each ethnic group or culture has a unique and significant contribution to make without loosing its identity or worth in functioning effectively in our pluralistic society.

The real issue in multicultural education, as discussed in this presentation, is how to gain a clear sense of cultural dynamics as they affect education and how to develop effective strategies for guaranteeing real equity in educational opportunity for all.

Multicultural education is the restructuring of educational priorities, commitments, and processes to reflect the reality of cultural pluralism as a fact of life in the United States. The presentor goes on to say that "multicultural education recognizes that the maintenance of cultural diversity is crucial not only to a particular group's survival, but to the basic tenets that support the democratic ideal."

To endorse cultural pluralism is to understand and appreciate the differences that exist among the nations' citizens.

A SURVEY OF THE STRUCTURE OF EDUCATION IN GHANA

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The main objective of this paper is to present a brief look at the structure of education in Ghana. This report, however, has not been done as a comparative study between the American and the Ghanaian school systems, but to the extent that this paper shows the development of education from elementary through the university level, one can make his own comparisons.

The data collected for this paper are based on personal interviews (during my visit to Ghana, Summer 1974) of students on all levels of education; professors from the University of Ghana, public school teachers, Ghana's newspapers and other reading materials on education in Ghana.

This paper deals exclusively with the public school systems which also includes the universities. The following conclusions can be deduced from this survey:

1. There are no public nursery schools. There are 6,684 primary schools, 3,607 middle schools, 149 secondary schools, 15 technical schools, 3 polytechnics, 59 teacher training colleges and 3 universities.
2. A child can enter school at age six and continue through the university supported by the government.
3. There are a shortage of schools on all levels, therefore education is highly competitive, very rigid and is a symbol status.
4. A child can skip the entire middle school, should he pass the Common Entrance Examination.
5. There are very few discipline or juvenile delinquent problems in the schools.
6. The main problems in the school systems are: overcrowding of classrooms, poorly trained teachers, too many students who cannot read well, the Common Entrance Examination is too rigid.
7. Too many students are being educated for non-existence White Collar Jobs.

The government and the school administrators are in the process of re-structuring the present educational system, dealing with the partial listing of problems presented above.

NOTE:

Schools	Number	Student Enrollment
Primary	6,736	39,000
Middle	3,659	446,695
Secondary	148-Plus	61,000
Teacher Training Colleges	59	7
Universities	3	10,000
Technical Institutions	15	8,329

SOME REMARKS ON A THEOREM OF OSTROWSKI

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A preliminary report of a study of the phenomenon of overconvergence in the complex plane. Definition of overconvergence, some examples, and an application of the proof of Hadamard's gap theorem.

ALABAMA'S REACTION TO ROOSEVELT'S 'CASH AND CARRY' PLAN OF 1939

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Alabama's reaction to the Roosevelt cash-and-carry plan of 1939 can be understood in light of the legislature which preceded the enactment of this measure. The failure of the League of Nation's after World War I, the failure of the Washington Disarmament Conference of 1921; and the failure of the Kellogg-Briand Pact to assure peace led indirectly to the cash-and-carry program as an attempt to keep the United States out of World War II.

Alabama's reaction to the Roosevelt plan was one of support; her congressmen voiced their approval in Congress both in the debate and by the final vote on the measure in 1939. The reaction of Alabama's congressmen and thus Alabama can be traced to those things which had some impact on the minds of the Southern people and were important to the prosperity of the South and Alabama. The freedom to trade abroad; the impact of English propaganda; the few foreigners of German, Italian, or Irish extraction and the degree of poverty in the South inclined Alabama to support Roosevelt's plan to sell goods of war to any nation that could pay for them in cash and haul them in their own ships.

ABSTRACT OF THE MIASMIST AS REFORMER: JOHN H. GRISCOM AS A TEST CASE

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Nineteenth century reform movements spanned all of life's activities, but one of the fundamental changes related to public health. In pre-germ theory America, the largest number of regular physicians were miasmists, who accepted the belief that filth caused disease and death. With this in mind, physician-reformers sought to ease the burden on the poor by cleaning the cities of America, and then improving the physical arrangements to maintain cleanliness. One of the leading physician reformers in Jacksonian America was Dr. John H. Griscom (1809-1874), who lived and worked in New York City. All of Griscom's reforms related to his acceptance of the miasma theory of disease causation. He worked for immigrants, prisoners, tenement dwellers, and other groups of New York

"havenots", always with the implication that filth dehumanized them and made them viscious. If the streets could be cleaned and the tenement buildings improved, then crime, vice, and corruption would be eased. As a miasmist, and as a romantic reformer, Griscom was a perfectionist and, therefore, overly sanguine. He tended to see all urban problems in relation to dirt and offal, taking a somewhat simplistic approach to a highly complex problem.

MEDICAL SCIENCES

METABOLISM OF THE ANTITHYROID DRUG 6-PROPYLTHIOURACIL (PTU)

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Recent reports have described the appearance of several PTU metabolites in tissues and body fluids after the administration of radioactive PTU. Only two of these metabolites, sulfate and PTU glucuronide, have previously been identified. In the present study, metabolites of PTU appearing in rat bile and urine were compared after administration of ^{14}C-PTU or ^{35}S-PTU. Chromatography of 24-hour urines or 6-hour biles resulted in the separation of several radioactive metabolites which were identified and quantitated. The results demonstrated that unchanged PTU was the most abundant urinary metabolite and confirmed the presence of PTU-glucuronide as a major metabolite in urine. Three other metabolites were identified as propyluracil, S-methyl propylthiouracil and sulfate. The major metabolite in urine appeared to be an S-conjugate of PTU or a PTU metabolite although positive identification has not yet been achieved. In bile, PTU-glucuronide was the most abundant metabolite. Small amounts of unaltered PTU and sulfate were also observed in bile. Further chromatography and analyses of the bile peaks resulted in the identification of two glucuronides of unknown PTU metabolites and three compounds which appear to be S-conjugates of PTU or PTU metabolites. Factors altering the total radioactivity excreted and the relative amounts of each metabolite in 24-hour urine or 6-hour bile were investigated. The data obtained demonstrated that PTU metabolites in urine varied quantitatively with age and the source of animal but that little alteration was produced by altering dose or by treatment with phenobarbital or thyroxine. In contrast, the relative amounts of biliary metabolites were substantially altered by varying PTU dose and by thyroxine administration.

ANTITHYROID DRUG ACCUMULATION IN THYROID GLANDS

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Factors influencing thyroidal accumulation of the antithyroid drugs propylthiouracil (PTU) and methimazole (MMI) were investigated. Six hours after the administration of ^{14}C labeled PTU, radioactivity in the thyroid glands of rats, guinea pigs and mice was 40, 8 and 164 times, respectively, that in whole blood. After MMI-^{14}C, thyroid levels were 5 and 2 times those in blood in rats and mice, respectively. Thyroidal accumulation of PTU and/or MMI was reduced by feeding a low iodine diet (LID) and further reduced by thyroxine administration. Both TSH and iodide administration increased PTU accumulation. The iodide stimulation increased with the dose from 0.012 to 0.1 µmole/100g animal but decreased progressively with higher doses. Thiocyanate at doses from 0.012 to 0.25 µmoles/100g had no effect on PTU but at 0.5 to 50 µmoles/100g produced a 30-50% depression of both PTU and MMI accumulation. Perchlorate administration reduced ^{131}I, PTU and MMI accumulation to 2, 46 and 68%, respectively, of the uninjected control. MMI administration reduced PTU uptake to only 10% of the control while iodide uptake was reduced to 66% and iodide organification to 11%. MMI did not appear to compete stoichiometrically with PTU since one molecule of MMI blocked the accumulation of several molecules of PTU. The data obtained indicate that thyroidal accumulation of PTU and MMI are generally influenced by the same factors influencing iodide metabolism, except LID. In addition, the data suggest that PTU and MMI accumulation are more closely related to iodide organification than to iodide trapping.

REGULATION OF ANTITHYROID DRUG ACCUMULATION IN ISOLATED THYROID CELLS

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Isolated thyroid cells were prepared from fresh porcine thyroids and used as a model system for studying thyroidal accumulation of the antithyroid drug 2-propylthiouracil. Thyroid cells incubated with $Na^{125}I$ or ^{35}S-PTU accumulated radioactivity to reach cell/medium (C/M) ratios ranging from 5-30 for ^{125}I and from 1.5-10 for ^{35}S-PTU. PTU accumulation was inversely related to PTU concentrations with C/M ratios declining from 8.2 at 0.001 µmole/ml to 1.8 at 0.1 µmole/ml. Addition of NaI increased PTU uptake up to 300% with progressively greater stimulation being produced with iodide concentrations from 0.001 to 10.0 µmoles/ml. Similar concentrations of thiocyanate produced a slight inhibition. Perchlorate inhibited iodide uptake to 36% of the control but had no effect on PTU uptake in the absence of iodide. Iodide stimulation of PTU accumulation was partially inhibited by perchlorate. Sodi-

um azide, an inhibitor of thyroid peroxidase, decreased PTU uptake to 30% of the control while iodide organification was inhibited 95%. Addition of TSH to cells incubated 2 hours inhibited PTU uptake but polystyrene beads had no effect on ^{125}I or ^{35}S-PTU uptake. The data presented demonstrate that isolated thyroid cells accumulate PTU and that cell accumulation is regulated by some of the same factors regulating uptake in the intact animal.

ACTIONS OF ANTITHYROID DRUGS ON HUMAN PMN LEUKOCYTES

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Isolated human polymorphonuclear leukocytes (PMN), like thyroid cells, have been shown to accumulate and metabolize iodide to iodotyrosines and thyroxine-like material. Similarly, thyroid cells and human PMN also accumulate and metabolize the antithyroid drug, propylthiouracil (PTU). Consequently, human PMN may serve as a model system for studying the mechanism of PTU accumulation and metabolism. Stimulation of phagocytosis with polystyrene beads (0.81 μ in diameter) resulted in a marked uptake of PTU and I^- with a subsequent increase in conversion of I^- to protein bound iodide. Incubation of PMN with PTU-^{14}C and ^{125}I produced cell/medium ratio of 3 and 7, respectively. Accumulation of PTU-^{14}C and ^{125}I was 10 times greater in phagocytic cells than resting cells. PTU uptake in both resting and phagocytic cells increased as the concentration of the drug increased but the phagocytic/resting cell ratio of PTU was markedly decreased. Another antithyroid drug, methimazole (MMI), decreased PTU uptake in phagocytic cells but had no effect on resting cells. Iodide concentrations ranging from 5×10^{-2} μM to 1 μM had no effect on PTU uptake but above 1 μM produced an inhibitory effect. Perchlorate had no effect on PTU uptake in resting or phagocytic cells. Phagocytosis, as quantitated by dioxane extraction of the ingested polystyrene beads, was decreased by PTU. Preliminary results indicate that the PTU accumulated in leukocytes was metabolized with the major metabolites appearing to be PTU disulfide, propyluracil (PU) and unaltered PTU.

MECHANISM OF ACTION OF DOPAMINE-B-HYDROXYLASE

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The pathogenesis of schizophrenia and/or affective disorders may involve abberations in the activity of noradrenergic neurons in the central nervous system. Since noradrenergic activity in the periferal nervous system is associated with the release of dopamine-B-hydroxylase (DbH) into the extracellular space and, therefore, increased levels of the enzyme in the serum, noradrenergic activity in the central nervous

system should be associated with the release of DbH into the extracellular space in the brain, which is continuous with the cerebrospinal fluid. Therefore, the level of DbH in the csf should be a reflection of the level of noradrenergic activity in the central nervous system. In order to measure the enzyme in csf a sensitive method for assay for DbH was developed, which includes the use of a small reaction volume and catalase to prolong the reaction. However, since the results from the application of this method to csf samples were unsatisfactory, a potentially more sensitive method for the assay of DbH is under development. In the latter method the release of tritium from specifically tritiated substrate to water is measured.

USE OF CATALASE AND ETHANOL IN THE SPECIFIC ENZYMATIC DETERMINATION OF GLUCOSE AND URIC ACID IN SERUM

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Automated procedures are presented for the determination of glucose and uric acid in serum utilizing the specificity of uricase and glucose oxidase coupled with a relatively interference free indicator reaction for peroxide utilizing catalase, ethanol, NADH, and alcohol dehydrogenase. Results from the use of these methods compare favorably with reference manual methods utilizing hexokinase or ultraviolet uricase procedures. Using the Technicon Auto Analyzer II system, excellent linearity is obtained for serum samples with up to 500 mg/dl or 16 mg/dl for glucose and uric acid, respectively. The glucose method is remarkably free from interference by uric acid, creatinine, thiols, ascorbic acid and blood preservatives; day-to-day coefficients of variation are less than 1.7%. The uric acid method shows a day-to-day coefficient of variation of less than 1.9%. These new methods do not employ carcinogenic materials, and all of the reagents are commercially available from a variety of suppliers.

LOUIS PASTEUR AND HIS CONTRIBUTIONS TO HUMANITY

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Louis Pasteur (1822-1895) was born at Dole, France. He proved that racemic acid was composed of a dextrorotatory compound and a levorotatory compound and this result gave birth to the new science, stero-chemistry. He disproved the theory of spontaneous generation. His researches on fermentation were concerned with fermentation of milk, beet sugar, wines, and beer. He showed that heating beer and wines at 55° to 60° C prevented them from becoming acid. The pasteurization of beer and milk resulted. He revitalized the cultivation of the silkworm industry and the silk industry of France. He proved that anthrax spores could survive

for years and that they could contaminate the grass above burial grounds because earthworms would carry the spores to the surface where they collected on the vegetation. He developed a vaccine for chicken cholera as well as one for swine fever. Pasteur showed that the medullary tissue became involved before an animal died of rabies. By desiccating medulla tissue, he proved that it lost its power to transmit the disease, rabies. By injecting tissue that had been desiccated 14 days, it did not produce rabies. The next day the animal was injected with tissue that had been desiccated thirteen days and so on using tissue with increased virulence until the medulla tissue of an animal that had died of rabies was used. The animals were vaccinated against rabies.

Pasteur suffered a stroke in his 46 year but recovered and performed many of his famous researches during the next twenty-five years.

EFFECT OF DBcAMP ON SCN^- INHIBITED GASTRIC MUCOSA

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Using the Rana pipiens gastric mucosa in vitro, SCN^- was investigated to determine its site of action. SCN^- has been known to be a reversible inhibitor of H^+ secretion without inhibiting chloride transport. These effects were observed in the isolated frog stomach as SCN^- (10^{-2}M) inhibited spontaneous or histamine (10^{-5}M) stimulated secretion, and was reversed by washing. The addition of SCN^- caused an immediate increase in PD which was also reversed by washing. All compounds were added to the nutrient (serosal) bathing solution.

$N^6,O^{2'}$ Dibutyryl adenosine 3',5' cyclic monophosphate (DBcAMP) was then studied to determine its effects on SCN^- inhibited mucosa. DBcAMP (4 mM) stimulated H^+ secretion following SCN^- (10^{-2}M) inhibition but would not stimulate following amytal (10^{-2}M) inhibition. By using a concentration of SCN^- two to ten times the concentration of DBcAMP present, inhibition could again be effected. Beginning with low doses and increasing concentration in a stepwise manner it was possible to stimulate with DBcAMP, and then inhibit with SCN^-. DBcAMP was ineffective in reversing SCN^- inhibition at a $[SCN^-]$ greater than 40 mM. The increase in PD by SCN^- was not reversed by addition of DBcAMP or return of the acid secretion rate.

Thus, SCN^- may have an action on the stimulatory pathway for acid secretion in vitro, perhaps competing with cAMP. (This work was supported by NIH grant AM 17315, and Faculty Research Grant 82-6205.)

HEART MITOCHONDRIA COMPARED WITH LIVER AND BRAIN MITOCHONDRIA ISOLATED FROM E-LE RATS THROUGHOUT THEIR LIFESPAN; FUNCTIONAL ASPECTS

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To gain insight into changes occurring in aging, we are engaged in a long-term evaluation of some oxidative functions of mitochondria from organs frequently found functionally impaired in older individuals. Although currently restricted to rats, we have previously reported (Emerson, G. M. and Emerson, J. D., Effect of long-term androgen-estrogen therapy of lifespan of the female rat, *J. Ala. Acad. Sci. 37*: 371-372, 1966) that major pathology of old rats is similar to that of old humans.

This study is directed toward the question: Do systematic changes occur with age in: adenosine diphosphate stimulated oxygen uptake; cytochrome oxidase activity; glutamate dehydrogenase (GDH) activity and succinate dehydrogenase (SDH) activity? To date we have made determinations on mitochondria isolated from sixty-nine randomly selected animals (from our closed colony) of known age. Average male age is 288 days; female average age is 329 days. We have found heart, liver and brain mitochondria *consistently* to *differ* from each other in *oxygen uptake; GDH activity* and *SDH activity* whereas there is no difference in the cytochrome oxidase activities.

Group	MEAN ± STANDARD ERROR OF MEAN (all values per mg. mito. prot.)			
MALE	O_2 Uptake [a] natoms/min	Cytoch. Oxid. [b] Δ OD/min	SDH [c] nmoles/min	GDH [d] nmoles/min
Liver	68.9 ± 4.7	13.6 ± 0.9	110.4 ± 6.3	176.4 ± 26.3
Heart	101.0 ± 7.0	17.4 ± 1.5	233.0 ± 17.7	26.6 ± 3.7
Brain	98.9 ± 8.8	16.7 ± 1.4	97.5 ± 8.0	30.6 ± 2.8
FEMALE				
Liver	75.6 ± 6.6	15.9 ± 1.2	125.4 ± 10.3	199.5 ± 21.6
Heart	118.6 ± 15.2	18.1 ± 1.5	265.0 ± 22.0	20.8 ± 2.3
Brain	119.1 ± 9.0	19.2 ± 1.4	123.2 ± 13.2	41.8 ± 4.8

Statistical evaluation performed by group comparison:
a) Male liver vs heart $P = 7.23 \times 10^{-5}$; liver vs brain $P = 1.35 \times 10^{-3}$
Female liver vs heart $P = 4.7 \times 10^{-3}$; liver vs brain $P = 3.17 \times 10^{-5}$
b) No significant differences
c) Male liver vs heart $P < 3.4 \times 10^{-5}$; brain vs heart $P < 3.2 \times 10^{-5}$
Female liver vs heart $P < 1 \times 10^{-8}$; brain vs heart $P < 1 \times 10^{-8}$
d) Male liver vs heart $P < 1 \times 10^{-8}$; liver vs brain $P < 1 \times 10^{-8}$
Female liver vs heart $P < 1 \times 10^{-8}$; liver vs brain $P < 1 \times 10^{-8}$; heart vs brain $P < 4.81 \times 10^{-5}$

This study was aided by Faculty Research Grants of the University of Alabama in Birmingham and by Private Donations Grant (JECA).

ENGINEERING

MODELING OF RADAR TARGETS

E. W. Smith, D. G. Burks, and E. R. Graf
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In theoretical analyses for the determination of tracking errors associated with precision radars, it is necessary to accurately model the type of target (aircraft) that will be utilizing the system. The fundamental considerations for target modeling include geometry (physical) of the target, electromagnetic geometry of the target (radar cross-section), and the type of tracking errors to be considered in the simulation.

In this presentation we consider small private aircraft to be the type using the system; we will model these aircraft using three types of models: An ellipsoidal scattering complex, a collection of point scatterers, and a collection of non-isotropic point scatterers. These three types of models will give the necessary variation in the radar cross section to give reasonable results for the tracking errors considered.

Types of tracking error allowed in the simulation will include glint, scintillation, and multipath.

SIMULATION MODELING OF THE MARINE TERMINAL SYSTEM

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The marine terminal may be viewed as a facility whose function is the transfer of commodities between inland and marine modes of transportation. From this standpoint, the terminal system may be broken down into the components of (1) the terminal facility, (2) the inland transport mode, (3) the marine transport mode, (4) the commodity, (5) operations performed within the facility, and (6) the control mechanism which governs the performance of operations. Utilizing this approach, a simulation model of the marine terminal system may be developed. The availability of data and the complexity of interactions among the above components may necessitate the adoption of a somewhat broader view of the terminal system. Such problems and alternative approaches are discussed in relation to the development of a simulation model of general cargo flow through the Alabama State Docks to be used in experimenting with various system configurations in view of expected increases in container and LASH/Seabee barge traffic through the facility.

A DIGITAL SORTING SYSTEM CONTROLLER

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The problem of sorting products or classifying end items as they come off the production line occurs often in the manufacturing process. In general a conveyer belt system transports a variety of items of different shapes, sizes, and composition. The Digital Sorting System Controller accepts information from an operator or some mechanical means of sensing the differences in the objects under consideration and internally generates a code particular to each classification of items. It then keeps track of the whereabouts of each of these objects as they move down the conveyer belt and issues an actuating signal at the appropriate time to cause the removal of a particular piece of material from the conveyer and its placement in a designated bin. The organization, design, and implementation of the digitally controlled conveyer system is discussed.

ON AUGMENTING A MULTI-USE HYBRID COMPUTING SYSTEM

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The simulation of hardware-in-the-loop (HWIL) missile components in real-time requires the computational speed of the simulator to be fast enough to permit closed-loop testing of guidance and control units in a realistic manner. As the fidelity of simulations increase and simulations of systems demanding faster response are developed, additional capacity is required. A determination has been made that a parallel processor, tied into the existing analog coupler driver, with associated peripheral hardware would increase the computing capacity in an efficient and cost effective manner. The recommended approach would require the least amount of change to the existing simulation system, allow production to continue with minimal interruption, and provide the additional computing capacity required. A list of hardware required to augment the facility and its contribution in the overall system is documented herein. Briefly the list includes acquisition of additional digital memory, secondary mass storage, port expanders for the physical tie-in, additional amplifiers, and analog resolvers.

NAVIGATION OF THE SPACE TUG VEHICLE

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Auburn University, Auburn, Alabama

A general definition of and the main objectives of the Space Tug vehicle navigation and guidance system are studied with respect to mission capabilities, gound-support, and on-board computational requirements. As a "worst case" the low-earth orbit to geosynch orbit maneuver was studied since it is the most demanding of accuracy. The nonlinear dynamics of the system (due to an Iterative Guidance Mode guidance law and gravity) are used to develop a general state estimator using noisy optical and accelerometer measurements to compute the six state vector of position and velocity in an inertial coordinate frome. This state vector information is required in order to drive the guidance law which forces the vehicle to fly to its destination.

The navigation and guidance system is to require little ground support (men, radar, computers, etc.) and for this reason an accurate on-board implementable scheme is required. Particular emphasis was given to simplifying dynamical equations for the state estimator so as to reduce computer computation time and storage. Simulations are presented to illustrate the validity of the approach used and difficulties encountered in implementation.

NUMERICAL SOLUTION FOR THE SURFACE CURRENT DISTRIBUTION ON A PERFECTLY CONDUCTING CYLINDER

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This paper describes an investigation of the surface current distribution on a cylindrical dipole. The study consists in two parts: The development of an integral equation describing the current density and the computer program used to solve the integral equation itself.

The development of the integral equation is subject to the following considerations: The equation is found for the surface current distribution at the surface of a perfectly conducting cylindrical dipole of radius, a, and half-length, h, oriented symmetrically along the z-axis in a cartesian coordinate system. The dipole is driven by a slice generator.

The numerical solution employs one of the appropriate moment methods as a solution technique, and the slice generator is approximated numerically as a large voltage across a small gap.

RANGE INSTRUMENTATION SYSTEM DESIGN AND PERFORMANCE ANALYSIS

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This paper presents a configuration design and systems performance analysis for a vehicle tracking range configuration. Included are: (a) overall system configuration, (b) geometrical configurations for different tracking modes which include a ground mode for limited tracking coverage, and two airborne modes for extended tracking coverage. The airborne modes contain ground based transponders which are employed for aircraft navigation while the aircraft track the vehicles. The ground mode does not utilize the airborne configurations. These configurations are analyzed using a Bayesian Estimator and several system performance tradeoffs are made. These tradeoffs include: system tracking accuracy as a function of the various configurations, sensitivity analysis as a function of system parameters, and system tracking accuracy as a function of the motion of the airborne navigation triad.

THRUST VECTOR CONTROL

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Thrust vector control (TVC) has been used on some Army missile systems for the past two decades. Mechanization of this type control has enabled efficient control force generation during the missile boost phase. Also many analytical and correlation studies of TVC have been performed during the past 10 years.

In recent years, the Army Missile Command has been exploring different means of mechanizing TVC for simple directional control guidance, with major emphasis on packaging, low cost, efficiency and reliability. This paper summarizes some of the work accomplished in the recent past and presents some new mechanizations that are currently in model testing. Earlier primary emphasis had been placed on hot gas secondary injection mechanizations utilizing fluidic control elements. Recent mechanizations include use of a cylindrical protrusion, circulation control around fixed jet vane surfaces, and control of a gas generator power source utilizing a vortex valve. Results of preliminary experimental tests are presented, including side force, control ranges, shock shapes and relative efficiencies.

SOLUTION OF ELECTROMAGNETIC FIELD EQUATIONS IN CONCENTRIC SPHERE CAVITIES

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The space between two concentric conducting spheres forms a resonant electromagnetic cavity. The electromagnetic field equations must be satisfied in the cavity and boundary conditions must be enforced at the cavity walls. These conditions will be satisfied only by fields that exist at the resonant frequencies of the cavity.

The solution to the field equations in the concentric sphere cavity can be broken into two parts, one having non-zero electric field components transverse to the r-direction (TE) and the other having non-zero magnetic field components transverse to the r-direction (TM). Any total fields solution in the cavity can be expressed as a summation of these modes.

The ratio of the sphere radii greatly influences the frequency at which resonant modes occur in the cavity. The lowest order TE mode decreases in frequency as the spheres approach while the frequency of lowest order TM mode increases.

The Earth and ionosphere form a concentric sphere cavity with dominant mode frequency in the 7-12 Hz range.

EFFECTIVENESS OF AUDITORY WARNING SIGNALS IN INDUSTRIAL ENVIRONMENTS

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Auburn University, Auburn, Alabama

Previous research has shown that the intensity and frequency distribution of signal and background noise are important in predicting signal detectability, but the specific relationships were not clear in terms of a generally applicable predictive model or test.

In the present study, eight complex variable pitch acoustically engineered horn-type signals were used as test signals. All are commercially available. Four very sprectrally representative (Standard Industrial Classification) industrial noise backgrounds plus white noise were reproduced under laboratory conditions to provide test environments. Overall environmental intensity levels were between 90 and 100 dBA. Signal intensity levels used were from 80 through 105 dBA in increments of 5 dBA.

Operant reaction time to respond to a signal while performing a repetitive task was considered to be the most appropriate basic measure of detectability. A one-hand Purdue Pegboard Test was used in this study with the other hand free to make a rapid push button response. An ascending-descending schedule was used in presenting the various signal intensities in each noise environment. A Fast Fourier Analysis by computer enabled signal onset characteristics to be studied within intervals of 0.0125 sec.

Eight subjects with normal hearing served in the experiment. Exponential functions were developed relating mean reaction time to signal intensity (dBA) under each noise background. A predictive model involving the use of octave-band analysis, signal-noise ratios and reaction time was developed. This model enables auditory warning devices to be evaluated and compared on the basis of a single calculated selector factor.

ON AN ANTI-RADIATION MISSILE DECOY SIMULATION

Donald W. Sutherlin
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Redstone Arsenal, Alabama

Simulation methodology has been a topic of discussion and will continue to be. The purpose of this paper is to present an approach to time critical simulations that is currently employed in the Advanced Simulation Center at the U. S. Army Missile Command, Huntsville, Alabama. A realistic problem, that of Anti-Radiation missiles, forms the basis. An approach to time critical simulation, using modular blocks for various missile subsystems such as the guidance, the autopilot, and the actuator, is presented. The advantages in such areas as flexibility and program checkout are discussed.

Also presented are typical decoy schemes which could be used in order to limit the effectiveness of Anti-Radiation missiles.

APPLICATIONS OF LIQUID CRYSTALS TO OPTICAL IMAGING SYSTEMS

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In this paper we examine the applications of liquid crystals and liquid crystal panels to optical imaging systems. We examine first some of the electro-optic properties of liquid crystals, the basic operating principles of the LC as a component, and some typical applications to optical systems.

In liquid crystals, there are three basic categories relevant to our study; these are the dynamic-scattering liquids (DS), the quiescent-scattering liquids (QS), and the reflective-storage DS crystals or memory crystals. The typical DS liquid has a digital type property, in that it can be in two states, either translucent or transparent. These states can be voltage-controlled, and thus can be used as a medium in which to electronically write for optical reading. The QS liquids possess the inverse properties of the DS liquids, and are transparent where the regular DS liquids are translucent and vice-versa. The DS memory crystals can be used to store optical images.

The applications for LC panels that we have investigated have included a variable input aperture for an optical system and an LC voltmeter.

SINGULARITY EXPANSION METHOD APPLIED TO ELECTROMAGNETICS

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The time domain response of a linear circuit due to an arbitrary forcing function can be formulated through knowledge of the singularities and corresponding residues of the response function in the complex frequency plane. The addition of all of the residues multiplied by exponentially damped sinusoids yields the time domain response. Recently this method of classical circuit theory has been utilized in solving transient electromagnetic field problems, such as scattering from conducting bodies. This circuit theory technique as applied to transient field problems is called the Singularity Expansion Method (SEM). In this paper the Singularity Expansion Method is discussed in detail. An attempt is made to identify and discuss the various analogies between the solution to fields problems using the SEM and to lumped circuits problems using the classical circuit theory approach.

A COMPARISON OF RISK SUBJECTS SELECT FOR THEMSELVES AND THOSE THEY SELECT FOR SOMEONE ELSE

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Comparisons were made of risk subjects selected for themselves and those they selected for someone else. Personality factors which may influence decision making were also measured. Subjects performed in pairs, one being designated the decision maker and the other one, the performer. The decision makers selected tasks, for the performer to attempt, on the Purdue Pegboard. Hazard (objective probability of failure) was measured for eight conditions of potential gain (monetary pay-off) and loss (electrical shock).

Results indicated that subjects selected essentially the same risk for someone else as they selected for themselves. A significant negative correlation was found between mean hazard selection and scores on the thinking-feeling scale of the Myers-Briggs Type Indicator.

OPTIMAL ADAPTIVE CONTROL OF SPACECRAFT EIGENAXIS ROTATIONS

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Auburn University, Auburn, Alabama
and
Norman O. Speakman
U. S. Air Force
Eglin AFB, Florida

Conventional and adaptive attitude control of spacecraft which use control moment gyros (CMG's) as torque sources are discussed. Control laws predicated on the assumption of a linear system are used since the spacecraft equations of motion are formulated in an "eigenaxis system" so that they are essentially linear during "slow" maneuvers even if large angles are involved. The overall control schemes are "optimal" in several senses. Eigenaxis rotations and a weighted pseudo-inverse CMG steering law are used and, in the adaptive case, a Model Reference Adaptive System (MRAS) controller based on Liapunov's Second Method is adopted. To substantiate the theory, digital simulation results obtained using physical parameters of a Large Space Telescope type spacecraft are presented. These results indicate that an adaptive control law is often desirable.

BABINET'S PRINCIPLE APPLIED TO ELECTROMAGNETIC FIELDS SCATTERED BY CONDUCTING SCREENS WITH APERTURES AND CONDUCTING OBSTACLES

E. W. Smith, D. G. Burks, and T. H. Shumpert
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Auburn University, Auburn, Alabama

When examining the relationship between the problem of scattering of electromagnetic energy from plane, perfectly conducting obstacles, and the problem of transmission of electromagnetic energy through apertures in infinitely-thin perfectly conducting screens, a modified form of Babinet's principle may be formulated.

The extension of Babinet's principle may be promulgated as follows: Consider complementary electric and magnetic screens, such that the aperture in one is identical to the obstacle of the other. Babinet's principle for this situation states that the sum of the E-fields produced by the transmitted field through the aperture plus the E-field produced by the scattered field from the obstacle is equal to the incident field.

As an illustration at the extension of Babinet's principle, the reciprocity between radiation formulas is examined for the cases of a resonant half-wave slot in a perfectly conducting sheet and a perfectly conducting half-wave dipole.

ANTHROPOLOGY

ABORIGINAL STONE CONSTRUCTIONS ON MORGAN MOUNTAIN IN CALHOUN COUNTY

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Mountain-top stone constructions, said to be of aboriginal origin, are common throughout the Southeast.[1] Constructions of this general type, previously unrecorded, exist in a fair state of preservation on Morgan Mountain in Calhoun County, in close proximity to a site excavated in 1971 by the Choccolocco Archaeological Society. The author will exhibit slides of this locale, in the hope of interesting professional archaeologists in future excavation and/or preservation. He will also describe similar sites at De Soto Falls[2] and Fort Mountain, Georgia.

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[1]Smith, Phillip E., "Aboriginal Stone Constructions in the Southern Piedmont", University of Georgia, Laboratory of Archaeology Series, Report No. 4, Athens, Georgia (1962), pp. 1-47.

[2]Roberts, Ralph G., "Ancient Stone Fortifications at De Soto Falls, Little River, Alabama", Tennessee Archaeologist, 5, No. 2, (1949), pp. 18-21.

LATE ARCHAIC OCCUPATION IN NORTHWEST ALABAMA

Eugene M. Futato
Office of Archaeological Research
University of Alabama, University

It has long been recognized that the great span of time and culture within the Shell Mound Archaic probably contained a number of distinct cultures. Based on reports of previous work in northwest Alabama and current research in the area, it is now possible to isolate and begin to define one of these cultures.

This phase is termed the Perry phase after the Perry site Lu025 which contains a major component of the phase. The Perry phase is the terminal pre-ceramic occupation in the Western Middle Tennessee Valley. The approximate dates of the phase are 1600 B.C. to 1000 B.C., lying in the final part of the period previously defined as Archaic (3). The Perry phase, to date, is known to be present along the Tennessee River in western Alabama and its tributaries to the south. Presumably the tributaries to the north were also occupied at this time. The limits of the phase upstream and downstream at this time are not known. However, differences in the cultural material from the Flint River shell mound suggest that this area may be beyond the upstream limit of the Perry phase.

TEMPORAL AND SPACIAL SUBSISTENCE PATTERNS OF THE CENTRAL TOMBIGBEE RIVER

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Zooarchaeological analysis of the animal remains from four archaeological sites on the Central Tombigbee River has revealed that the prehistoric inhabitants utilized the white-tail deer *(Odocoileus virginianus)*, the wild turkey *(Meleagris gallopavo)*, and the cottontail rabbit *(Syvilagus floridanus)* respectively as their three most important vertebrate food sources. Twenty-four vertebrate species have been identified from these sites including various individuals of mammals, reptiles, fishes, and birds. Environmental reconstructions are accomplished based on the species of animals present at these sites. Twenty-two bone and antler artifacts are identified from the sites including antler flakers, awls, and a perforated deer phalange used in a game known as "cup-and-pin." Variations of shell pendant and bead manufacture through the Woodland and Mississippian periods are observed. Discussion of temporal and spacial activities includes a reconstruction of subsistence trends based on gross bone counts which reveal possible difficult times in the Transitional-Woodland-Archaic (1000 B.C. - 500 B.C.) and a peak during the late Woodland (Miller III) (500 A.D. - 1100 A.D.) of efficiency in the utilization of the environment.

HISTORIC INDIAN POTTERY ON THE NORTHERN GULF COAST

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University of South Alabama, Mobile

The aboriginal ceramic complex at the early Historic (1699-1760) French site of Port Dauphin (1Mb61) on Dauphin Island at the mouth of Mobile Bay is a multi-component of at least two periods within the Mississippian Tradition. The Port Dauphin pottery complex can be interpreted, in a cultural-historical context, as being an archaeological unit possessing certain traits that resemble, in design and form, wares characteristic of more than one cultural phase on the northern Gulf Coast.

Certain Port Dauphin pottery types exhibit a close external relationship to types previously defined in the pottery series of the Natchezan Phase of the Terminal Mississippian Period in the Lower Mississippi Valley (Quimby, 1942). Furthermore, Port Dauphin types are related to the Pensacola Series of the late Middle Mississippian Fort Walton Period in northwestern Florida (Willey, 1949). In terms of design elements, the Port Dauphin complex demonstrates a genetic relationship to other southeastern ceramic manifestations including incised motifs and patterns such as sun circles, the spiral meander and parallel curvilinear meander (one, two, and three lines). Also, related are rectilinear motifs the "herringbone" or "feather" and parallel line-filled opposed triangles. The close similarity of the proposed type

Port Dauphin Curvilinear Incised to Pensacola Three-lined Incised of the Pensacola series and to the numerous variants of Fatherland Incised and other Natchezan types seems to establish a definite link between these phases. Various punctated, pinched and brushed wares, and utilitarian types comprise the remainder of the Port Dauphin complex.

ARCHAEOLOGICAL INVESTIGATIONS ON NANNA HUBBA BLUFF

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The University of South Alabama Archaeological Research Project conducted an archaeological investigation of the proposed Dow Badische Chemical Company plant site between July and December, 1974. The plant site is located upon Nanna Hubba Bluff on the Tombigbee River immediately south of the Washington County line in the extreme northeast corner of Mobile County, Alabama. During the course of the archaeological salvage project sponsored by the Dow Badische Company, a total of six sites were excavated, revealing prehistoric occupation ranging from Early Archaic to Late Mississippian times as well as extensive historic activity.

The most frequently encountered cultural materials were ceramics of the Bayou La Batre-Tchefuncte series of the Early to Middle Woodland Tradition (Wimberly, 1960). Of the six sites that were excavated (1Mb83, 1Mb84, 1Mb87, 1Mb89, 1Mb90 and 1Mb91), five produced ceramic assemblages that were predominantly of the Bayou La Batre-Tchefuncte types, while only one site (1Mb90) was found to contain shell tempered Mississippian ware.

Evaluation of the materials from the sites on Nanna Hubba Bluff indicates that, although the area was frequently occupied for short periods of time by transient Archaic and Early Woodland groups, it was abandoned upon arrival of agriculturally oriented groups who preferred the fertile soil of the Mobile River Delta to the east and south. Early historic activity was evidenced by the presence of trade items and French ceramics. Nineteenth Century occupation was well represented by an abundance of white glazed earthenware and structural remains.

DELAY OF GRATIFICATION, PERSONAL CONTROL, ETHNIC STEREOTYPES, AND SELF-CONCEPTS FOR ANGLO AND NAVAHO HIGH SCHOOL SENIORS

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University of South Alabama, Mobile

This paper deals with differences between Anglo and Navaho males in the senior class of a multi-ethnic high school in delay of gratification, personal control, ethnic stereotypes of the average Indian and the average white man, and concepts of the actual or present self, ideal self, and self in five years and with the interrelations among these

variables within each ethnic group. A questionnaire was used to collect the data. Nine hypotheses were tested and most received at least some support. The most noteworthy findings, generally speaking, are the similarities of the Anglo and Navaho students in delay of gratification, personal control, and the different self-concepts, the much higher ratings of the Navahos for stereotypes of the average Indian, the positive correlations between delay of gratification and personal control for both ethnic groups, the negative interrelations between the stereotypes of the average Indian and the various self-concepts for the Anglos, the positive associations between the stereotypes of the average Indian and the different self-concepts for the Navahos, the positive correlations between the stereotypes of the average white man and the various self-concepts for both ethnic groups, and the positive associations among the different self-concepts within each ethnic group.

THE DEFINITION OF AN INDIAN IN THE UNITED STATES OF AMERICA, CANADA, AND MEXICO, 1975

Margaret Z. Searcy
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University of Alabama, Tuscaloosa

Rather than being defined largely in biological terms the concepts of race, specifically those pertaining to the Indian, have become socio cultural phenomena which vary from one country to the next. Differing criteria used in Canada, the United States of America, and Mexico for defining an Indian are discussed. Social scientists must take the variations in definition into account when conducting racial studies, especially those of a comparative nature, and race should be defined for each specific study.

CONTRACT ARCHAEOLOGY, NEW REQUIREMENTS, NEW GUIDELINES, BUT NOT NEW ARCHAEOLOGY

Majorie Gay
Alabama Archaeological Society, Standing Rock

I am not an authority on Contract Archaeology, but after attending during the last two years, most of the national and several international anthropological meetings, I believe I may be in a position to report some of what the experts, and also those not so expert, have had to say. While the debates concerning "method and theory" still rage on, there are plans being laid for what could become a far greater battle. Who will ultimately control Archaeology? The Federal Government, the State, an organization, a selected few or the voices of those who have dedicated their skills to a discipline which will honestly uncover the story of the past, study it, interpret it for the benefit of future mankind and make sure that an untarnished heritage will pass on to the next generations.

MINUTES
ANNUAL BUSINESS MEETING
Auburn University, Auburn, Alabama
April 5, 1975

After Dr. George Folkert's scientific lecture on Alabama's Environmental Problems, the meeting was called to order by President Boozer. A motion was made by Dr. Barker and seconded by Dr. Wilkes that the minutes be adopted. Motion carried.

REPORT OF THE SECRETARY (Danice H. Costes):

Total membership through April 3, 1975	762
Additions (December 7, 1974 to April 3, 1975):	
New members	20
Reinstated members	2
Total	22
Losses (December 7, 1974 to April 3, 1975):	
Resigned members	2
Deceased members	2
Total	4

REPORT OF THE TREASURER (Hoyt Kaylor): Jan. 1 - Dec. 31, 1974

RECEIPTS	ACTUAL	ESTIMATED
Membership Dues	$ 5,324.00	$ 3,600.00
Annual Meeting	1,840.74	1,000.00
Research Grants	438.00	200.00
Industry Contributions to AJAS Humanities Symposium	1,975.00	2,200.00
Gifts	240.00	
Interest from Certificate of Deposit	928.09	
Mailing Permit Refund	38.25	
Journal Subscriptions and Sales	49.00	
Total Net Receipts for the Period	10,833.08	$ 7,000.00
Closing of Passbook Savings Account	621.53	
Total Receipts	$11,454.61	

EXPENDITURES	ACTUAL	BUDGET
Publication of Journal (Eight Quarterly Issues)		10,600.00
Printing (Six Quarterly Numbers)	4,830.60	
Typing of Journal Copy	408.50	600.00
Honoraria for Editor	600.00	800.00
Assistance to AJAS		
Support		250.00
Industry Contributions to Humanities Symposium		2,000.00
Student Awards	55.00	150.00
Research Grants	500.00	400.00
Annual Meeting		
Expenses Net	668.96	250.00
Programs	108.15	600.00
Academy of Science Award (Outstanding Teacher)	100.00	150.00
Speakers, Officers' Expenses, etc.		200.00
Academy of Science Assessment	41.75	40.00
Operating Expenses		
Office of the President		125.00
Office of the Secretary	538.38	600.00
Office of the Treasurer	231.05	250.00
Office of the Editor-Newsletter		50.00
Office of Coordinator of Science Fairs	100.00	150.00
Office of Counselor AJAS		
Public Relations Committee		100.00
Supplies		200.00
Newsletter	185.25	400.00
Chairman, Membership Committee	60.00	150.00
Vice-Presidents (11 x $20.00)	60.00	220.00
Total Expenditures	$ 8,487.64	$18,285.00

Balance in Checking Account 12-31-73	207.52
Total Receipts	11,454.61
Total Expenditures	-8,487.64
Balance in Checking Account 12-31-74	$ 2,966.97

First National Bank, Birmingham, Alabama, Certificate of Deposit
Value 12-31-74 $ 7,500.00

Jefferson Federal Savings and Loan Association, Birmingham, Alabama, Savings Certificate
Value 12-31-74 $ 4,541.81

Dr. Hannah made a motion of approval of Dr. Kaylor's report. Dr. J. C. Wilkes seconded the motion. Motion carried.

REPORT OF THE AUDITOR (Dan C. Holliman and Paul C. Bailey):

"The books, as of this date, of the Alabama Academy of Science have been examined and found in good order."

REPORT OF THE COMMITTEE ON PLACE OF MEETING (Raymond F. Askew):

"The 1976 meeting was previously designated to be held at the University of South Alabama in Mobile. Communication with the Vice-President for Academic Affairs, Dr. Howard Phillips, ascertained that his office had been unaware that the invitation had been extended. He has assured us that they will be delighted to host the meeting. With regard to the dates, they are currently reviewing their calendar of events for April, 1976 and will recommend to our Executive Committee within a month, a weekend in that month. I have stated an Academy preference for the early part of the month.

The Committee has solicited an invitation from Dr. David Matthews to host the 1977 meeting at the University of Alabama in Tuscaloosa on April 29-30. The Committee recommends this location.

Communication has been received from Dr. James Wilkes, Troy State University, regarding the possibility of the Academy holding its annual meeting on that campus in 1978. The Chairman has advised Dr. Wilkes that this will be presented to the Executive Committee.

The Chairman wishes to suggest that henceforth invitations from institutions, after the details have been generally agreed upon, be obtained in writing from the proper official of said institution. This generally will mean the office of the President or a particular Vice-President of the institution. In addition, the question of acceptable time should be pre-established by the Executive Committee and the Committee on Place and Date of Meeting be so informed as a guideline for negotiating a meeting."

REPORT OF THE RESOLUTIONS COMMITTEE (George F. Brockman):

"WHEREAS the Alabama Academy of Science has held its 1975 meeting at Auburn University, and has enjoyed the hospitality of the University, Therefore:

BE IT RESOLVED that the Academy express its gratitude to Dr. Harry Philpott, President of the University, and to the University for hosting this meeting. To Dr. Lowell Wilson and the members of his host committee, Dr. James Harris, Dr. Ford Laumer, Dr. Helen Douty, Dr. Andy Weaver, Dr. Dotty Sherling, Mr. E. L. McGraw, and Mr. L. B. Williams; to Dr. Marllin Simon and Dr. Harold Beals; to Dr. Kenneth Sanderson, Dr. Cleveland Adams, Mr. Foy Thompson, and to the many members of the Faculty and Staff of Auburn University who contributed much to the success of this meeting, we the Academy members express our appreciation for their efforts in our behalf.

BE IT FURTHER RESOLVED that the Academy express its appreciation to those who retire from leadership this year, and especially to Dr. Reuben Boozer, President.

BE IT FURTHER RESOLVED that the Academy express its appreciation to Dr. Edward Mosley and to Dr. George Folkerts for their presentation to the Academy.

WHEREAS during the past year the Alabama Academy of Science has lost two of its members through death, Therefore

BE IT RESOLVED that the Academy extend its sympathy to the families of Mr. Eugene G. Fitzgerald and of Mr. J. E. McCaffrey.

BE IT FURTHER RESOLVED that an appropriate letter together with copies of this resolution be sent by the Secretary to the families of Mr. Fitzgerald and Mr. McCaffrey.

WHEREAS the scientific community of the State of Alabama has lost one of its greatest friends, and the Academy one of its trustees through the death of Mr. Walter Bouldin, now Therefore:

BE IT RESOLVED that the Academy extend its sympathy to the family of Mr. Bouldin.

BE IT FURTHER RESOLVED that an appropriate letter, together with a copy of this resolution be sent by the Secretary of the Academy to the family of Mr. Bouldin.

It is hereby moved by the Committee on Resolutions that the above be accepted and entered in the Minutes of the Academy." Seconded by Dr. Denton. Resolutions carried.

REPORT OF THE NOMINATING COMMITTEE (Howard Carr):

"The Nominating Committee for the Alabama Academy of Science submits the following nominees for the offices designated."

President 1975-1976

Tom Denton
Samford University

President-Elect 1975-1976

Urban Diener
Auburn University

Associate Counselor, AJAS 1975-1978

Don Grigsby
University of Alabama
Birmingham

Treasurer 1975-1978

W. J. Wingo
University of Alabama
Birmingham

Board of Trustees 1975-1978

Howard Carr—Auburn
Elroy Curl—Auburn
Al Henderson—Muscle Shoals, TVA
Joseph Thomas—University of North Alabama

Biological Sciences:

Vice-President: Carl Dixon, Auburn University
Vice-Chairman : Margaret Miller, University of South Alabama

Chemistry:

Vice-President: Robert Head, Gadsden State Junior College
Vice-Chairman : T. H. Jackson, University of South Alabama

Geology:

Vice-President: Robert Cook, Auburn University
Vice-Chairman : George Brockman, University of Alabama, Birmingham

Forestry, Geography and Conservation:

Vice-President: Frank Himmler, University of North Alabama
Vice-Chairman : Eugene M. Wilson, Mobile, Alabama

Physics and Mathematics:

Vice-President: David Agresti, University of Alabama, Birmingham
Vice-Chairman : William Alford, Auburn University

Industry and Economics:

Vice-President: Billy P. Helms, University of Alabama, University
Vice-Chairman : Vacant

Science Education:

Vice-President: Hollis Fenn, University of North Alabama
Vice-Chairman : Dan Whitson, Decatur, Alabama

Social Sciences:

Vice-President: George C. Whatley, Birmingham, Alabama
Vice-Chairman : Charles G. Summersell, University of Alabama

Medical Sciences:

Vice-President: Raymond Lindsay, University of Alabama, Birmingham
Vice-Chairman : George S. Hand, Jr., University of Alabama, B'ham

Engineering:

Vice-President: Charles D. Haynes, University of Alabama
Vice-Chairman : Reynold Shotts, Tuscaloosa, Alabama

Anthropology:

Vice-President: Noel R. Stowe, University of South Alabama
Vice-Chairman : Avery Church, University of South Alabama

There were no nominations from the floor. Dr. E. Carmichael moved that we accept the slate of officers as presented by the Nominating Committee. Dr. Barker seconded the motion. The motion was carried by a plurality of votes.

REPORT OF THE CHAIRMAN FOR REGIONAL SCIENCE FAIRS (G. Twellmeyer):

"Seven of the Regional Science Fairs of Alabama all operated successful Fairs this year. All seven Fairs have affiliated with the International Science and Engineering Fair and will send two Finalists to compete in the ISEF to be held in Oklahoma City, May 12-17. Arrangements for travel and hotel reservations have been made by the Office of the Coordinator for the entire Alabama delegation. Adult companions for the Finalists will be Dr. Ben B. Chastain from the Central Region and Mrs. R. L. Crawford, Jr. from the Mobile Region. In an effort to cut down on expenses since there are only 7 regions sending Finalists, a third adult will not go this year. Students representing the 7 regions going to the ISEF are:"

CENTRAL REGION: Samford University	Robert L. Bleidt Patrick Wayne Mardis
EASTERN REGION: Auburn University	Christine Rice Lee Sims
MOBILE REGION: Spring Hill College	Sandy Kirkland Art Renfro
NORTH REGION: University of Alabama Huntsville	Susan Grooms David Middleton
NORTHEASTERN REGION: Jacksonville State University	Karin Levisque Mike Norton
WESTERN REGION: University of Alabama	Stephen Hughes Steve Odewahn
SOUTH REGION: Troy State University	Pam Sellers Patrick Price

REPORT OF THE GORGAS SCHOLARSHIP FOUNDATION, INC. (C. E. Feazel):

"I am happy to have the opportunity to announce the winner and alternates in the Alabama Science Talent Search held by the Gorgas Scholarship Foundation, with the Cooperation of the leading colleges and universities in Alabama, the Alabama Academy of Science, the Junior Academy of Science, and the national Westinghouse Science Talent Search operated by Science Service.

We wish to thank the Academies for allowing the Foundation a place on their program and also to thank Dr. H. O. Beals and Auburn for their planning and hospitality.

We had ten finalists in the Talent Search, and they can expect to receive offers of tuition scholarships from several of the colleges in the state. The Foundation is making one cash award this year, to the first-place winner among the finalists.

Alternates:

Ninth: Jeffrey Howard Lyons, Fort Payne High School. Teacher, Joanne H. Durham.

Eighth: Denisa Faye Day, Austin High School. Teacher, M. Dean McMinn.

Seventh: Susan Diane Grooms, Austin High School. Teacher, M. Dean McMinn.

Sixth: Raymond Phillip Quigley, Bradshaw High School. Teacher, Mary Nell Gonce.

Fifth: Alexander Garry Nein, Randolph High School. Teacher, William T. Smathers, Jr.

Fourth: Jay Parker Mashburn, Homeward High School. Teacher, Barbara Murphy.

Third: John Breese Dollison, Randolph High School. Teacher, Julia Snyder.

Second: Eloise Karin Lundberg, Huntsville High School. Teacher, Mrs. Robert S. Snyder.

First: Beaumont Lawson Shelton, Bradshaw High School. Teacher, Mary Nell Gonce.

Winner of a cash award of $250 per year for 4 years of college—William Flynn Walker, Randolph High School--teachers, Julia Snyder and William T. Smathers, Jr."

REPORT OF THE STATE COUNSELOR OF THE JUNIOR ACADEMY OF SCIENCE (James Welker):

"The AJAS has completed a very good year with active participation in all nine regions. A Regional Paper Competition was held in each region prior to February 1, 1975, with the State Competition being held at UAB on February 15. From 35 papers presented, seven winners were selected, six to participate in the National JSHS to be held at West Point (April 30-May 3, 1975), and one to participate in the Bell Laboratories Tour (May 18-20, 1975)."

Winners were:

John Dollison, Randolph High School, "The Nutritional Requirements of *Spirillospora* 261"

Monty Shelton, Bradshaw High School, "Some observed Effects of Electromagnetic Fields of Different Strengths on *Chalomydomonas reinhardi* and *Bacillus subtilis*"

Velda Denise Pugh, Parker High School, "Detection, Identification and Measurement of Air Pollution—Its Effects on Man"

James Henderson, Cottonwood High School, "A Pre-Venturi Carburetion System"

Raymond Quigley, Bradshaw High School, "Two Divisibility Properties of the Arithmetic Difference Between an Integer and Its Digital Inverse in Base N" (Winner of Bell Labs Tour)

Lennez Spencer, Opp High School, "Silver Recovery from Photographic Negatives"

W. Flynn Walker, Randolph High School, "Biomedical Applications of Holographic Nondestructive Testing"

"The paper presented by William Flynn Walker was judged to be the outstanding paper of this year's competition; therefore, it was selected to be read at the National JSHS competition as the entry from Alabama.

This year's recipient of the $500.00 Henry Moody Walker Scholarship is Randy Dale Vaughn, Route 1, Pisgah, Alabama."

Other awards:

AAS Research Grant	-	Laura Waters Lawrence County High School 512 Coffey Street Moulton, Alabama $100.00
		George Ackley Austin High School 904 Betty Street, S.W. Decatur, Alabama 50.00
AAAS Award	-	Mildred Shofner Randolph High School 914 Fagan Springs Drive Huntsville, Alabama
Outstanding Science Teacher	-	Phyllis E. Walch Cottonwood High School Cottonwood, Alabama
Outstanding Region	-	North Region, Regional Counselor Herbert Walker Huntsville

Dr. Carmichael moved that the host institution for each past annual meeting be included in future programs. Dr. Thomas seconded the motion. Motion carried.

Dr. Boozer introduced Dr. Denton, the president of AAS, 1975-1976. Dr. Denton briefly outlined his program for the Academy for 1975-1976. The meeting was adjourned by President Denton at 11:15 a.m.

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PROJECTIONS OF EXPORT TONNAGES THROUGH THE PORT OF MOBILE, ALABAMA, 1980-2035[a/b/]

Venkareddy Chennareddy and Sheldon Schaffer[c]

ABSTRACT

The purpose of this paper is to present the export tonnages projected to move through the Port of Mobile, Alabama, during the period 1980-2035, and the methodolgy used to prepare these projections, which were developed as part of a larger study for the Corps of Engineers. A simple model was used to relate a nine-year moving average of export tonnages of each important commodity exported from the Port of Mobile to per capita gross product in the rest of the world, to a time variable, and to a dummy variable. The dummy variable was added only in selected cases to improve statistical fit. The regression equations were estimated separately for thirty-seven major commodities, which accounted for 88% of total export tonnages in 1970. The remaining tonnages were treated as a single commodity.

Total exports of all commodities from the Port of Mobile were 2.94 million tons in 1970, and are projected to increase to 6.71 million tons in the year 2035. The tonnages of ten of the thirty-seven major commodities are projected to decrease and tonnages of the remaining commodities are projected to increase.

INTRODUCTION

The Corps of Engineers has recently been investigating the feasibility of improving Mobile Harbor in Alabama. The feasibility of the improvement will be determined by a benefit-cost analysis to be carried

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a. For complete details and for individual commodity projections, refer to Long-Range Projections of Waterborne Commerce for Mobile Harbor and Black Warrior-Tombigbee Waterway, Alabama, Final Report to Corps of Engineers, Project 2961, by the same authors and others, Southern Research Institute, March 28, 1975.

b. An earlier version was presented at the meetings of the Alabama Academy of Sciences, April 8, 9, and 10, 1976, held at Mobile, Alabama.

c. Venkareddy Chennareddy was Senior Economist, Southern Research Institute and is now Acting Chairman, Department of Economics, Talladega College, Talladega, Alabama. Sheldon Schaffer was Head, Economic Research and Planning Section and is currently Head, Health Systems Planning Section, Southern Research Institute, Birmingham, Alabama.

out by the Corps. This analysis will be based in part on estimates of the type and volume of commodities expected to be exported from Mobile Harbor, excluding the effects of the opening of the Tennessee-Tombigbee waterway.

The purpose of this paper is to present the export tonnages projected to move through the Port of Mobile, Alabama during the period 1980-2035, and the methodology used to prepare these projections, which were developed for the Corps of Engineers as part of a larger benefit/cost analysis. Because of limitations on funds available for this study and, more importantly, because of the limited usefulness of highly complex models, a relatively simple model was utilized in carrying out this study. The period covered by the projections is generally coincident with that of the estimated 50-year life of the harbor project, which is expected to be completed in 1985.

METHODOLOGY AND DATA

Introduction

Exports of all commodities from the Port of Mobile amounted to 2.94 million tons in 1970 and, during the period 1953-1970, fluctuated from a low of 0.93 million tons in 1954 to a high of 9.36 million tons in 1966. Some of these major commodities, whose export tonnages accounted for about 88 percent of the total export tonnages in 1970 through the Port of Mobile, are as follows: wheat, which has been exported as flour and flour grain to Java and other countries in the Orient; soybeans, about 70 percent of which has been exported to Europe and about 30 percent of which has been exported to Japan and other countries in the Orient for both direct human consumption and livestock production; rice, which has been exported mainly to Asia; corn, which went mostly to the Carribean, Germany, and Korea; grainmill products, which have been shipped mainly to Europe, Australia, and the Carribean for both human and livestock consumption; and lumber for use in construction and manufacturing, which has been exported mainly to Europe, with the remainder going to Africa and the Orient. Other commodities include all types of metal products, in categories such as steel and metal products, primary forms, shapes, plates, ferro alloys and metal scrap, which were exported to Europe, Central America, South America, Isreal, the Carribean, and Asia; fertilizer and fertilizer materials, which have been exported to Siagon, Europe, and Japan; paper and paperboard, which were sent mainly to Central America and Europe; coke and petroleum asphalt, which have been exported mainly to Japan and South America, and, to a lesser extent, Mediterranean countries and Africa for use in road construction; pig iron, which has been exported to Turkey, Italy, Japan, Argentina and, to a lesser extent, Asia; and basic chemicals, which went mainly to Europe.

Methodology

Exports from the Port of Mobile have in the past been shipped to countries in various continents, but in the future might be shipped to a completely different set of countries and continents. This assumption

suggests the need to utilize a simple model which relates the export tonnages of each commodity from the Port of Mobile to an overall world-wide variable in the model given below:

$$\text{Log}_e Y = \beta_0 + \beta_1 (X_1)^{-\beta_2} + \beta_3 (T)^{-\beta_4} + \beta_5 Z$$

where: Y = the nine-year moving average of export tonnages of a given commodity from the Port of Mobile,

X_1 = per capita gross product of the rest of the world expressed in 1970 U.S. dollars,

T = a time variable,

Z = a dummy variable, which takes a value of 1 for the increasing portion of the trend and 0 for the decreasing portion; the dummy variable was included in the regression only for a commodity that had a clear differential trend (upward and then downward or downward and then upward),

β_0, β_1, β_3, and β_5 are the parameters to be estimated, and

β_2 and β_4 = either 1 or 2, individually, depending upon the steepness of the trend of the commodity.

With the use of appropriate estimated coefficients, the model provides two types of trends. In the case of commodities whose exports follow a clear upward trend, the export tonnages increase, but at a decreasing rate, and reach an upper limit as per capita gross product of the rest of the world increases and as time passes. In the case of commodities whose exports depict a clear downward trend, the export tonnages decrease, but at a decreasing rate, and reach a lower limit close to zero. Separate regression equations were estimated for the thirty-seven leading commodities and for the rest of the total tonnages, which were treated as one aggregate commodity. This type of model incorporates existing trends in American comparative advantage for some commodities and disadvantage for other commodities.

Explicit recognition should be given at this point to the general problems of statistical reliability in preparing projections of the type described in this article. Sixty-year projections prepared by the method employed in this study, or by any method, must necessarily result in large confidence intervals for each estimate at any level of confidence. Despite the low reliability of such long-range projections, the need for them is predicated on the fact that those responsible for making long-term investment decisions need some type of guideline data. A relatively simple and inexpensive model is the type employed in this study. Use of more complex econometric models was considered, but econometric

models, especially those applied to comparable long-term periods, are notoriously costly and fail to offer any superiority in predictive performance.[1]

Historical Data

A nine-year moving average of export tonnages of each commodity was computed for the period 1953-1970 so as to obtain a clear long-term trend in the export tonnages of each commodity. This method provided data for the ten-year period, 1957-1966. A clear long-term trend was required for each commodity in order to choose an appropriate mathematical form of the model to be used.

In the absence of reliable and varied information on socioeconomic conditions and on developmental planning efforts of various countries in the distant future, projections of gross product in the respective continents with the use of a consistent and sophisticated econometric model are almost impossible. Under such conditions, projecting gross continental product with the use of recent average annual compound growth rates is regarded as good as any other method. Average annual compound growth rates from 1960 to 1970 for various continental areas were highest in the Near East and East Asia. The United States and Canada led the world in per capita gross national product, but continental gross product in the Near East and Eastern Europe was growing at a rate that was faster than in any other continental area during that period.

The acutal population for 1965 and the United Nations medium projections of population for the period 1970-2000 for the various continental areas were taken as the base data for projecting population to the year 2035. Because of a lack of reliable information on death rates, birth rates, intercontinental migrations, and public programs for the control of fertility and death rates in various continents beyond the year 2000, a simple modified logistic model was developed for projecting population beyond the year 2000 for each continental area. This model provides eventual upper limits to population in these areas.

The per capita gross product for the rest of the world was derived by dividing the gross product by the population for the rest of the world.

The time period covered by the regression analysis is 1957-1966, which provides ten yearly observations on the moving average of export tonnages of each commodity from the Port of Mobile and on per capita gross product for the rest of the world. The time variable 'T' takes a coded value of 1 in 1957 and an addition of 1 for each subsequent year.

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[1]This point has been made repeatedly in the literature. See, for example, Gorti V. L. Narashimham, Archer McWhorter, Jr., Richard R. Simonds, "A Comparison of Predictive Performance of Alternative Forecasting Techniques: Time Series Models vs. An Econometric Model", *1975 Business and Economic Statistics Section Proceedings of the American Statistical Association*, pp. 459-464, and the numerous references quoted in that paper.

PROJECTIONS

Input Data

The world gross product in 1970 was 3.225 trillion dollars and is projected to increase, as measured in constant dollars, to 4.178 trillion dollars in 1975 and to 64.380 trillion dollars in 2035. World population in 1970 was 3.684 billion and is projected to increase to 4.109 billion in 1975 and to 10.662 billion in the year 2035. The compound annual growth rate of world population during the period 1965-1970 was 2.29 percent and is projected to decrease to 1.15 percent during the period 2030-2035, The derived per capita world gross product based on projected world population and projected world gross product is expected to increase from $1,018 in 1975 to $6,041 in 2035.

Export of Tonnages

The projected total tonnages of exports passing through the Port of Mobile are given in the accompanying Table I. Total estimated exports of all commodities from the Port of Mobile were 2.346 million tons in 1970 and they are projected to increase to 2.858 million tons in 1975. Total exports are projected to be 6.711 million tons in the year 2035, indicating a three-fold increase during the period 1970-2035. The tonnages of ten of the thirty-seven major commodities exported from the Port of Mobile are projected to decrease. They are: wheat, defense shipments, brick and tile, dried milk solids, naval stores, plywood and veneers, petroleum asphalt, paper manufactures, and coal and lignite. The tonnages of the rest of the thirty-seven major commodities are projected to increase.

CONCLUSION

As their per capita gross product increases in the future, countries outside the United States, especially underdeveloped countries, are expected generally to develop their own industries and to exploit their own resources, thereby becoming relatively less dependent on United States exports, including less dependency on exports from the Port of Mobile. Based on this assumption for most of the commodities exported through the Port of Mobile, total export tonnages are projected to increase three-fold during the forecast period, which is considerably less than the projected increase in gross national product in the United States and the increase in overall tonnage movements in, out, and through the Port of Mobile during that period.

Table I
Projected Total Export Tonnages, All Commodities,
Port of Mobile, 1970-2035
(in thousands of short tons)

Year	Export tonnages
1970	2345.8
1975	2858.1
1980	3347.1
1985	3809.6
1990	4232.2
1995	4642.0
2000	5008.2
2005	5344.1
2010	5645.4
2015	5915.6
2020	6155.7
2025	6366.8
2030	6511.8
2035	6711.4

APPENDIX: Table 1
Gross Product and Per Capita Gross Product, 1970, and Related Growth Rates, Selected Countries and Continental Areas, 1960-1970[a]

Country or continent	Percentage average annual growth rate of per capita gross product 1960-1970	Per capita gross product, 1970 (in US dollars, before devaluation)	Percentage average annual growth rate in gross product	Gross product, 1970 (in billions of US dollars, before devaluation)
U. S. A.	2.7	4.756	b	964.27
Canada	3.4	3,755	4.5	80.38
Western Europe	3.7	2,083	4.5	772.89
Eastern Europe	4.2	1.366	5.0	173.28
U. S. S. R.	3.4	1.522	4.7	455.82
Africa, excluding South Africa	2.0	155	3.8	61.98
South Africa	3.4	805	4.1	16.69
Near East	4.4	375	6.3	54.10
South Asia, excluding Near East	1.7	103	4.1	74.99
East Asia	3.6	613	6.0	257.03
Oceania	2.6	2,288	4.0	43.93
Latin America	2.8	516	4.9	140.03

a. Herman Kahn and Anthony Wiener, *The Year 2000, A Framework for Speculation on the Next Thirty Years*, The MacMillan Company, New York Fifth Printing, 1968; *Gross National Product, Growth Rates and Trend Data by Region and Country*, May, 1972, Office of Statistics and Reports, Bureau of Program and Policy Coordination, Agency for International Development.

b. Annual average growth rates are expected to vary from 3.0% to 6.5% during the period 1970-2035, based on projected gross product.

APPENDIX: Table 2
Projected Gross Product in Continents, Continental Areas, and Selected Countries, 1970-2035
(in billions of 1970 U.S. dollars, before devaluation)

	North America			Europe				Africa		
	U.S.A.	Canada	Total	Western Europe	Eastern Europe[b]	Total[b]	U.S.S.R.	Africa, excluding South Africa	South Africa	Total
1970	964.27	80.38	1,044.65	772.28	173.28	946.17	455.82	61.98	16.69	78.67
1975	1,317.22	100.17	1,417.38	963.15	221.15	1,184.31	573.49	74.69	22.55	97.23
1980	1,651.17	124.83	1,775.99	1,200.27	282.25	1,482.52	721.54	90.00	30.46	120.45
1985	2,022.72	155.56	2,178.27	1,495.75	360.24	1,855.98	907.81	108.45	41.15	149.59
1990	2,446.72	193.85	2,640.57	1,863.97	459.76	2,323.73	1,142.15	130.68	55.58	186.26
1995	3,025.61	241.57	3,267.18	2,322.84	586.78	2,909.62	1,436.99	157.46	75.09	232.55
2000	3,723.34	301.05	4,024.38	2,894.68	748.90	3,643.58	1,807.95	189.74	101.44	291.18
2005	4.543.11	375.16	4,918.26	3,607.29	955.81	4,563.09	2,274.67	228.64	137.03	365.67
2010	5,439.55	467.51	5,907.06	4,495.33	1,219.88	5,715.21	2,861.88	275.51	185.11	460.62
2015	6,394.85	582.61	6,977.45	5,601.99	1,556.91	7,158.90	3,600.68	331.99	250.06	582.05
2020	7,557.87	726.03	8,283.90	6,981.09	1,987.05	8,968.14	4,530.20	400.05	337.81	737.86
2025	8,842.07	904.77	9,746.83	8,699.70	2,536.03	11,235.70	5,699.68	482.06	456.35	938.40
2030	10,308.60	1,127.50	11,436.10	10,841.40	3,236.68	14,078.00	7,171.06	580.88	616.48	1,197.35
2035	11,949.50	1,405.07	13,354.50	13,510.30	4,130.91	17,641.20	9,022.28	699.96	832.80	1,532.75

APPENDIX: Table 2 (Cont'd)
Projected Gross Product in Continents, Continental Areas, and Selected Countries, 1970-2035
(in billions of 1970 U.S. dollars, before devaluation)

	Asia							
		South Asia						
	Near East	South Asia, excluding Near East	Total	East Asia[b]	Total[b]	Oceania	Latin America	World
1970	54.10	74.99	129.09	257.03	386.12	43.93	140.03	3,224.48
1975	73.43	91.68	165.10	343.96	509.07	53.45	177.87	4,177.90
1980	99.66	112.08	211.74	460.30	672.04	65.03	225.93	5,275.23
1985	135.27	137.01	272.28	615.99	888.27	79.12	286.98	6,618.28
1990	183.60	167.50	351.10	824.33	1,175.42	96.26	364.53	8,280.00
1995	249.19	204.77	453.96	1,103.13	1,557.08	117.11	463.03	10,437.50
2000	338.22	250.34	588.55	1,476.23	2,064.78	142.48	588.15	13,151.00
2005	459.05	306.04	765.09	1,975.52	2,740.60	173.35	747.07	16,547.70
2010	623.05	374.13	997.19	2,643.69	3,640.87	210.91	948.93	20,742.60
2015	845.65	457.38	1,303.03	3,547.85	4,840.88	256.60	1,205.34	25,924.90
2020	1,147.77	559.16	1,706.92	4,734.44	6,441.36	312.19	1,531.04	32,511.60
2025	1,557.83	683.58	2,241.40	6,335.74	8,577.14	379.83	1,944.75	40,763.70
2030	2,114.39	835.68	2,950.06	8,478.64	11,428.70	462.12	2,470.25	51,193.60
2035	2,869.79	1,021.62	3,891.41	11,346.30	15,237.70	562.23	3,137.75	64,379.89

b. Excluding U.S.S.R.

APPENDIX: Table 3
Projected Population and Compound Growth Rates for the Regions of the World and for the Entire World, 1970-2035
(in billions of persons)

	East Asia		Europe		U.S.S.R.		Middle Asia		South East Asia		South West Asia	
Year	Actual	Growth rate	Actual	Growth rate	Actual	Growth rate	Actual	Growth rate	Actual	Growth rate	Actual	Growth rate
1970	0.958	2.37	0.462	0.76	0.243	1.10	0.766	2.99	0.288	2.99	0.077	3.05
1975	1.062	2.08	0.479	0.74	0.257	1.07	0.879	2.77	0.332	2.87	0.090	3.01
1980	1.161	1.80	0.497	0.72	0.271	1.05	1.001	2.64	0.380	2.75	0.104	2.96
1985	1.253	1.54	0.515	0.70	0.285	1.02	1.133	2.50	0.433	2.60	0.120	2.90
1990	1.337	1.29	0.532	0.67	0.300	1.00	1.273	2.35	0.489	2.45	0.138	2.84
1995	1.411	1.08	0.550	0.65	0.314	0.97	1.418	2.19	0.548	2.29	0.159	2.76
2000	1.476	0.89	0.568	0.63	0.330	0.94	1.568	2.02	0.609	2.13	0.181	2.68
2005	1.531	0.73	0.585	0.61	0.345	0.91	1.720	1.86	0.671	1.96	0.206	2.59
2010	1.577	0.59	0.603	0.58	0.361	0.89	1.871	1.69	0.733	1.78	0.233	2.50
2015	1.615	0.48	0.620	0.56	0.377	0.86	2.019	1.53	0.794	1.61	0.262	2.39
2020	1.647	0.38	0.637	0.54	0.393	0.83	2.162	1.37	0.854	1.45	0.294	2.28
2025	1.672	0.31	0.654	0.52	0.409	0.80	2.297	1.22	0.910	1.29	0.327	2.15
2030	1.693	0.24	0.671	0.50	0.425	0.77	2.423	1.07	0.963	1.13	0.362	2.03
2035	1.710	0.19	0.687	0.48	0.441	0.74	2.540	0.94	1.012	0.99	0.397	1.90

APPENDIX: Table 3 (Cont'd)
Projected Population and Compound Growth Rates for the Regions
of the World and for the Entire World, 1970-2035
(in billions of persons)

	Africa		Latin America		Oceania		North America		World	
Year	Actual	Growth rate	Actual	Growth rate	Actual	Growth rate	Actual	Growth rate	Actual	Growth rate
1970	0.351	2.99	0.287	3.13	0.019	2.52	0.229	1.38	3.684	2.29
1975	0.406	2.97	0.333	3.05	0.021	2.39	0.245	1.35	4.109	2.20
1980	0.470	2.95	0.386	2.97	0.024	2.24	0.261	1.31	4.560	2.10
1985	0.543	2.93	0.445	2.87	0.026	2.09	0.278	1.27	5.036	2.00
1990	0.627	2.90	0.510	2.76	0.029	1.93	0.296	1.23	5.535	1.90
1995	0.723	2.87	0.581	2.64	0.032	1.77	0.314	1.19	6.055	1.81
2000	0.832	2.84	0.658	2.51	0.034	1.62	0.333	1.15	6.593	1.71
2005	0.955	2.80	0.740	2.38	0.037	1.46	0.352	1.11	7.146	1.62
2010	1.095	2.76	0.827	2.23	0.040	1.31	0.371	1.06	7.714	1.53
2015	1.251	2.71	0.916	2.08	0.042	1.17	0.390	1.02	8.292	1.45
2020	1.426	2.65	1.008	1.91	0.044	1.03	0.410	0.97	8.878	1.37
2025	1.621	2.59	1.100	1.76	0.046	0.91	0.429	0.93	9.471	1.29
2030	1.836	2.52	1.192	1.60	0.048	0.79	0.449	0.89	10.066	1.22
2035	2.072	2.44	1.281	1.45	0.050	0.69	0.468	0.84	10.662	1.15

APPENDIX: Table 4
Derived Per Capita Gross Product by Continents Based on
Projected Gross Product and Population, 1970-2035
(in 1970 U.S. dollars, before devaluation)

	North America	Europe	U.S.S.R.	Africa	South Asia	East Asia	Asia	Oceania	Latin America	World
1970	4,562	2,048	1,876	224	114	268	185	2,312	488	876
1975	5,785	2,473	2,232	240	127	324	215	2,545	534	1,018
1985	7,836	3,604	3,185	276	162	492	302	3,043	645	1,316
1990	8,921	4,368	3,807	297	185	617	363	3,319	715	1,497
1995	10,405	5,290	4,576	322	214	782	440	3,660	797	1,725
2000	12,085	6,415	5,479	350	250	1,000	539	4,191	894	1,996
2005	13,972	7,800	6,593	383	295	1,290	664	4,685	1,010	2,317
2010	15,922	9,478	7,928	421	352	1,676	825	5,273	1,147	2,690
2015	17,891	11,547	9,551	465	424	2,191	1,032	6,110	1,316	3,129
2020	20,205	14,079	11,527	517	516	2,875	1,299	7,095	1,519	3,663
2025	22,720	17,180	13,936	579	634	3,789	1,648	8,257	1,768	4,307
2030	24,384	20,981	16,873	652	787	5,008	2,101	9,628	2,072	5,078
2035	28,538	25,679	20,459	740	985	6,635	2,693	11,245	2,449	6,041

APPENDIX: Table 5
Regression Equations for Projecting Exports of Selected Commodities from the Port of Mobile

	Dependent variable	Constant	Independent variables				R^2	N	F
			1/PGNP	$1/(PGNP)^2$	$1/T^2$	Z			
Wheat	Log_eA1	1.7217	+1567.6 (90.1)				0.9742	10	302.40
Soybeans	Log_eA2	7.4674	-939.7 (251.5)			0.24483 (0.07355)	0.6725	10	7.18
Defense shipments	Log_eA3	-5.2939	+4085.5 (1130.7)				0.6200	10	13.05
Corn	Log_eA4	5.8902		-202070.0 (255410.0)	-0.1211 (0.2663)	0.22443 (0.20662)	0.3372	10	1.02
Lumber	Log_eA5	5.4441	-697.3 (90.8)				0.8805	10	58.95
Brick and tile	Log_eA6	-3.6985	3263.4 (287.0)				0.9417	10	129.30
Flour and Flour grain	Log_eA7	6.8358		-454010.0 (267990.0)	-0.6600 (0.2794)	0.21892 (0.21680)	0.8757	10	14.09
Dried milk solids	Log_eA8	0.2126	868.5 (360.8)				0.4200	10	5.79
Clay products	Log_eA9	4.6177	-841770.0 (118790.0)				0.8625	10	50.21
Ferroalloys	Log_eB1	5.8781	-1077.3 (248.3)				0.7018	10	18.83
Iron and steel (semi-finished)	Log_eB2	5.8090	-1562.3 (531.9)				0.5188	10	8.63
Naval stores	Log_eB3	0.4714	1480.2 (371.5)			0.11999 (0.10163)	0.8326	10	17.410
Residual fuel oil	Log_eB4	1.4967	-737.3 (701.4)			0.08645 (0.18802)	0.2185	10	0.98

APPENDIX: Table 5 (Cont'd)
Regression Equations for Projecting Exports of Selected Commodities from the Port of Mobile

	Dependent variable	Constant	Independent variables 1/PGNP	$1/(PGNP)^2$	$1/T^2$	Z	R^2	N	F
Plywood and veneers	$Log_e B5$	-9.4853	5072.6 (617.9)				0.8939	10	67.40
Petroleum asphalt	$Log_e B6$	-3.8334	2698.2 (328.6)				0.8939	10	67.42
Paper manufactures	$Log_e B7$	-3.5070	3050.8 (527.8)				0.8068	10	33.42
Iron and steel shapes	$Log_e B8$	3.4289	-409.7 (827.2)				0.0577	10	0.25
Basic chemicals	$Log_e B9$	6.8290	-1202.7 (128.7)				0.9561	10	87.29
Iron and steel scrap	$Log_e C1$	2.2342	+929.9 (350.1)				0.5851	10	7.05
Rolled steel mill products	$Log_e C2$	6.0874	-1306.3 (229.1)				0.8024	10	32.50
Pig iron	$Log_e C3$	90.1948		-19922000.0 (5618800.0)	3.4298 (9.8892)		0.7550	10	10.79
Metal manufactured products	$Log_e C4$	32.2267		-5277000.0 (753560.0)	-2.2770 (1.3262)		0.9508	10	67.72
Coke and petroleum asphalt	$Log_e C5$	235.6321		-59237000.0 (17624000.0)	40.7450 (31.0190)		0.6575	10	6.72
Grain mill products	$Log_e C6$	901.7786		-231080000.0 (37942000.0)	151.7300 (66.7800)		0.8652	10	22.47
Rice	$Log_e C7$	200.5596		-50544000.0 (6608600.0)	30.7770 (11.6310)		0.9125	10	36.51

APPENDIX: Table 5 (Cont'd)
Regression Equations for Projecting Exports of Selected Commodities from the Port of Mobile

	Dependent variable	Constant	Independent variables 1/PGNP	$1/(PGNP)^2$	$1/T^2$	Z	R^2	N	F
Coal and lignite	$Log_e C9$	-3.6670		+2091600.0 (626680.0)	-0.3854 (1.1029)		0.7301	10	9.47
Limestone	$Log_e D1$	7.2634		-1774100.0 (549760.0)	+0.8338 (0.9676)		0.6709	10	7.14
Crushed rock	$Log_e D2$	122.6491		-32344000.0 (9166000.0)	+24.4990 (16.1320)		0.6705	10	7.12
Clay	$Log_e D3$	30.7551		-6532000.0 (337010.0)	+1.8013 (0.5932)		0.9883	10	297.40
Paper and paperboard	$Log_e D4$	103.3219		-19809000.0 (1291800.0)	+4.2806 (2.2736)		0.9823	10	194.95
Fertilizer and fertilizer materials	$Log_e D5$	86.0950		-21638000.0 (2467700.0)	+11.7020 (4.3430)		0.9347	10	50.18
Cut stone products	$Log_e D6$	2.8217		-644450.0 (470870.0)	+0.6127 (0.8287)		0.2195	10	0.98
Iron and steel primary forms	$Log_e D7$	143.1462		-37644000.0 (11766000.0)	+27.9220 (20.7080)		0.6278	10	5.91
Iron and steel pipe and tube	$Log_e D8$	59.7230		-10861000.0 (2524100.0)	-8.1455 (4.4426)		0.9025	10	32.40
Fabricated metal products	$Log_e E1$	12.3519		-3110500.0 (275290.0)	+1.6559 (0.4845)		0.9599	10	83.80
Electrical machinery	$Log_e E2$	8.8493		-2265300.0 (287500.0	+1.3852 (0.5060)		0.9170	10	38.69
Nonferrous metal scrap	$Log_e E3$	7.0818		-1760600.0 (156140.0)	+1.0463 (0.2748)		0.9581	10	80.10

PGNP = Per capita gross national product of the world, except U.S.A. (in 1970 dollars)
T = Time variable
Z = Dummy variable taking 1 for increasing trend and 0 for decreasing trend. This variable was included in the regressions for only those commodities whose tonnages clearly depicted either upward and then downward trends, and downward and then upward trends. In other cases, Z waa not included as an independent variable in the regression equation.

DETERMINATION OF Q ELEMENTS OF $A^TQ + QA = -C$ FOR A CLASS OF MODEL-REFERENCE ADAPTIVE SYSTEMS*

B. K. Colburn †

J. S. Boland, III ††

ABSTRACT

A general approach for obtaining bounds on the ratios of certain elements of a positive-definite, symmetric matrix Q is developed. This information is shown to be of importance in the design and implementation of model reference adaptive system techniques previously developed. An approach amenable to computer aided design is given. Two techniques for obtaining solutions to Q are compared with regard to speed, accuracy, and output data utility.

INTRODUCTION

Through the use of a linearized error characteristic equation design technique [1, 2, 3], it is possible to determine adaptive gain parameters necessary to implement a class of model-reference adaptive system (MRAS) controllers. However, one particular difficulty with this design approach is the lack of a straightforward technique for the selection of certain elements of a positive - definite (p.d.) Q matrix utilized in the adaptive control laws [1, 2, 4].

The problem has been around for over a decade, since Kalman's basic paper introducing Lyapunov Theory to the Western World [5]. It was shown that for the basic plant

$$\dot{\underline{x}} = A\underline{x}$$

and an "energy-like" function

$$V = \underline{x}^T Q \underline{x} + \{\text{p.d. terms in } \underline{x} \text{ of a particular form}\}$$

where $\underline{x}$ is the n^{th} order state vector and Q is a positive - definite (p.d.) symmetric n x n matrix, the time derivative of V is

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$$\dot{V}\Big|_{\dot{\underline{x}}} = \underline{x}^T (A^TQ + QA)\underline{x} + \{\text{negative - definite (n.d.) terms in } \underline{x}\}$$

By requiring $(A^TQ + QA)$ to be n.d., stability of $\underline{x}(t)$ was assured. Unfortunately, the means with which to select the elements of $Q = [q_{ij}]$ is not simple. Using a straightforward algebraic approach two numerical techniques for determining certain ratios of Q elements for use in model-reference adaptive system (MRAS) designs are presented here. The techniques are shown to place some restrictions on a positive-definite matrix, but the restrictions are justified and an explanation given as to the effect on system parameter bounds. The overall approach is shown to be directly amenable to computer aided design (CAD) as the design techniques are reduced to linear systems concepts. Comparative results of two solution approaches to the synthesis problem of obtaining ratios of Q elements are given and sample data presented to illustrate the ease of use and minimal computer burden required.

SYSTEM DESCRIPTION

Assuming a plant-model MRAS controller of the form

$$\dot{\underline{x}}_m(t) = A_m\underline{x}_m(t) + B_m\underline{u}(t) \qquad \text{Model} \qquad (1)$$

$$\dot{\underline{x}}_p(t) = A_p(t)\underline{x}_p(t) + B_p(t)\,\underline{u}(t) \qquad \text{Plant} \qquad (2)$$

$$\underline{e}(t) = \underline{x}_m(t) - \underline{x}_p(t) \qquad (3)$$

it has been shown for a number of Lyapunov - designed MRAS controllers that a linearized error characteristic equation can be used to determine the adaptive error transient response. As developed in [3, 6] the basic error characteristic equation is

$$1 + \frac{\left[\sum_{i=1}^{n} q_{in}s^{(i-1)}\right]\left[\sum_{j=1}^{p} K_j s^{(j-1)}\right]}{s\Delta_m(s)} = 0 \qquad (4)$$

where p is the "type" of adaption

p = 1 from [4]

p = 2 from [1]

p = 3 from [2]

$$K_1 = \alpha_{n1}\, x_{1_m}^{o^2} + \alpha_{n2}\, x_{2_m}^{o^2} + \ldots + \alpha_{nn}\, x_{n_m}^{o^2} + \gamma_1 u_1^{o^2} + \ldots \gamma_r u_r^{o^2}$$

and K_2, K_3 similar except (β, δ) and (ρ, σ) replace the constants (α, γ) respectively

q_{ij} - elements of p.d. Q matrix satisfying $A_m^T Q + Q A_m = -C$,

$x_{i_m}^o$ - steady state model operating condition

$\Delta_m(s)$ - model characteristic equation

In order to obtain the simple form in (4) it is necessary that A_m be in the phase variable cononical form

$$A_m = \begin{bmatrix} 0 & 1 & 0 & \cdots & 0 \\ 0 & 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \vdots & & \\ -a_{n1}^m & -a_{n2}^m & -a_{n3}^m & \cdots & -a_{nn}^m \end{bmatrix} \quad (5)$$

$$\Delta_m(s) = s^n + a_{nn}^m s^{n-1} + \cdots + a_{n2}^m s + a_{n1}^m$$

The minimal stability conditions are found when p = 1. In this case, selection of the ratios of certain elements of the Q matrix is needed to construct the controller. However, it is not at all clear whether stable zero locations according to (4) are allowed by the Lyapunov sufficiency condition that

$$A_m^T Q + Q A_m = -C, \; C \text{ p.d.} \quad (6)$$

The traditional approach has been to select C=I and use the corresponding Q elements resulting from (6). However, as given in (4), the ratios of certain elements of Q tend to determine the adaptive error transient response, and it is flexibility in the selection of Q elements that is desired. Since it is C that is normally selected first, a reverse analytical procedure for computing Q would be desirable. As shown in [6], however, this becomes unwieldly for large n. Instead, an algorithmic approach will be adopted.

DEVELOPMENT OF Q RATIO BOUNDING TECHNIQUE

Using (6) in the form

$$\begin{bmatrix} 0 & 0 & 0 & \cdots & -a_{n1}^m \\ 1 & 0 & 0 & \cdots & -a_{n2}^m \\ 0 & 1 & 0 & \cdots & \\ \vdots & & & & \\ & & 1 & & \\ & & \vdots & & \\ 0 & 0 & 0 & \cdots & -a_{nn}^m \end{bmatrix} \begin{bmatrix} q_{11} & q_{12} & \cdots & q_{1n} \\ a_{21} & q_{22} & \cdots & q_{2n} \\ & \vdots & & \\ & & & \\ q_{n1} & q_{n2} & \cdots & q_{nn} \end{bmatrix} +$$

$$\begin{bmatrix} q_{11} & q_{12} \cdots q_{1n} \\ q_{21} & q_{22} \cdots q_{2n} \\ \vdots & \\ q_{n1} & q_{n2} \cdots q_{nn} \end{bmatrix} \begin{bmatrix} 0\ 1\ 0\ 0 \ldots . 0 \\ 0\ 0\ 1\ 0 \quad \ldots \\ 0\ 0\ 0\ 1 \quad \ldots 0 \\ \vdots \\ -a_{n1}^{m} \ -a_{n2}^{m} \quad \ldots -a_{nn}^{m} \end{bmatrix} = \begin{bmatrix} 2c_{11} & & \\ & 2c_{22} & \\ & & \ddots 2c_{nn} \end{bmatrix} \tag{7}$$

a matrix equation for determining bounds on the ratios q_{in}/q_{nn} in (4) results. The RHS C matrix is in a form guaranteeing p.d., $c_{ii}>0$. Equating terms, n^2 linear algebraic equations results. Since the LHS forms a symmetric matrix there are only $\frac{n(n+1)}{2}$ independent equations in the $\frac{n(n+1)}{2}$ variables q_{ij} and they are of the form

$$\left.\begin{aligned} -2q_{1n}a_{n1}^{m} &= -2c_{11} \\ q_{11}-q_{1n}a_{n2}^{m} - a_{2n}a_{n1}^{m} &= 0 \\ q_{12}-q_{1n}a_{n2}^{m} - q_{3n}a_{n1}^{m} &= 0 \\ a_{13}-q_{1n}a_{n4}^{m} - q_{4n}q_{n4}^{m} &= 0 \\ &\vdots \end{aligned}\right\} \begin{array}{l} n \text{ equations} \\ q_{ij} = q_{ji} \quad i \neq j \\ i, j = 1, 2, \ldots, n \end{array} \tag{8a}$$

$$\left.\begin{aligned} q_{1(n-1)}-q_{1n}a_{nn}^{m} - q_{nn}a_{b1}^{m} &= 0 \\ 2q_{12} - 2q_{2n}a_{n2}^{m} &= -2C_{22} \\ q_{22} + q_{13} - q^{2}{}_{n}a_{n3}^{m} - q_{3n}a_{n2}^{m} &= 0 \\ q_{23} + q_{14} - q_{2n}a_{n4}^{m} - q_{4n}a_{n2}^{m} &= 0 \\ q_{2(n-1)} + q_{1n} - q_{2n}a_{nn}^{m} - q_{nn}a_{n2}^{m} &= 0 \\ &\vdots \\ 2q_{(n-1)n} - 2q_{nn}a_{nn}^{m} &= -2c_{nn} \end{aligned}\right\} \begin{array}{l} n-1 \text{ equation} \\ \\ \\ \\ \\ 1 \text{ equation} \end{array} \tag{8b}$$

Defining $m = \frac{n(n+1)}{2}$, note that (8) is in the form

$$\underline{A}\underline{x} = \underline{b} \tag{9}$$

where A - m x m constant matrix

$\underline{b}$ - m x 1 vector consisting of 0's, 1's and $-c_{ii}$ terms

$$\underline{x}^T = [q_{11}\ q_{12} \cdots q_{1n}\ \ q_{22}\ \ q_{23} \cdots q_{2n} \cdots q_{nn}] \qquad (10)$$

The A matrix is made up of 1's, 0's, and coefficients of the model characteristic equation. As given in [7, 8], use of the direct matrix product [9] can reduce a system such as (6) to that of (9). The direct, or Kronecker product is defined as

$$P = A \times B = \begin{bmatrix} b_{11}A & b_{12}A \cdots b_{1n}A \\ B_{21}A & b_{22}A \cdots b_{2n}A \\ b_{n1}A & b_{n2}A \cdots b_{nn}A \end{bmatrix} \qquad (11)$$

where

A, B are nxn matrices

P is $n^2 x n^2$

Using the symmetry of Q, C in (6) reduces (11) to an $\frac{n(n+1)}{2}$ x $\frac{n(n+1)}{2}$ matrix. Rules for the construction of A in (9) are formulated in [7] and listed in the Appendix.

$\underline{b}$ is a constant vector which is constructed as

$$\underline{b}^T = [-c_{11}\ \ 0\ \ \ldots -c_{22}\ 0\ 0\ 0\ \ -c_{33} \ldots -c_{nn}] \qquad (12)$$

$$q_{11}\ q_{12} \cdots q_{22} \cdots q_{2n}\ q_{33} \cdots q_{nn}$$

where the q_{ij} elements above each entry of $\underline{b}$ define the numerical location (i.e. 8th, 9th) in the vector array. The location of the element q_{ij} or c_{ij} in $\underline{x}$ and $\underline{b}$ respectively can be determined from the integer p, representing the p^{th} element. This is found from

$$p = (j-i+1) + \sum_{\ell=0}^{i-2} (n-\ell) \qquad , j \geq i \qquad (13)$$

$$\sum_{\ell=0}^{-1} (n-\ell) \triangleq 0$$

Since there are m linearly independent equations and unknowns, $|A| \neq 0$ and A^{-1} exists. Solving (9),

$$\underline{x} = A^{-1}\underline{b} = \underline{f}(c_{ii}) \tag{14}$$

and by iteratively sweeping through the ranges of values of the c_{ii} from 0^+ to ∞^- it is possible to obtain numerical values for the range of values of q_{jn}/q_{nn} which, through (4) have been shown to help determine the zero compensator locations. The sweeping of the c_{ii} is performed as follows: let ε_i be a small positive number and $2c_{ii}$ the i^{th} diagonal element of C. Initially let $c_{ii} = \varepsilon_i = \varepsilon$ and then iteratively increase c_{nn} to some arbitrarity large value c_{max}, then increment $c_{(n-1)(n-1)}$ and sweep through all c_{nn}'s.

It is possible, for n=2, to obtain exact analytical results relating the c_{ii} and A_m elements to the q_{ij}/q_{nn} ratios [10]; for n=3, exact results also are available for a special form of V[11]. However, for the general case, the analytical computations involved are unwieldly, and are best performed by numerical methods.

A computer program, QRANGE, has been written to numerically obtain allowable root location combinations so that the dynamic error response can be easily designed. The program is made up of a series of subroutines which order the data so that a series of root-locus like curves are plotted by the computer showing the location of variation of each of (n-1) roots, where n is the system order. This is accomplished by ordering the roots in groups of (n-1) from largest to smallest (most positive to most negative) and then plotting all first terms, second terms, etc. of each group together.

It is felt that by displaying a representative sample of root locations that guarantee asymptotic adaptive error stability, the designer can make a judicious choice of some root combination which is close to that desired. Overall error transient response can then be improved beyond this by using the methods in [2, 3].

A brief discussion of the special form of the C matrix used is in order. For the Q-ratio determination technique presented, it has been assumed that C is a diagonal matrix of positive entries. This is a sufficient but not necessary condition for C to be p.d. and symmetric. Such a form "overconstrains" the problem inasmuch as it is possible for

$$c_{ij} \neq 0,\ i \neq j$$

and still guarantee that C be p.d., symmetric, but the given diagonal form simplifies the analytical derivation considerably and allows for straightforward computations. The alternative is that, to account for all possible combinations of the c_{ii} elements for which C is p.d., all off-diagonal elements must be swept though their ranges of values. This would require complete knowledge of all the non-linear relationships guaranteeing p.d., a situation that is difficult for low order (n=2, 3) systems and completely unwieldly for higher order ($n \geq 4$) systems. Therefore, the range of values of the Q ratios obtained with the sweeping techniques are

a subset of a larger, unknown set Ω. This simply means the designer is forced to select the zeros from a smaller choice set ω, $\omega \in \Omega$. Whatever combination is chosen, however, will insure an asymptotically stable error response, but perhaps the transient error response will be less than "optimal". Because of the lack of a straightforward technique for varying all the c_{ij} elements and still maintain p.d., the diagonal C matrix approach appears to offer the only viable alternative. Such techniques as Sylvesters formula are not felt to be practical for the general case here.

A second point to consider is that of sensitivity of the delta increments used in sweeping through the c_{ii} terms in a priori fixed range of values. By using discrete step increments the possibility of "missing" that particular (unknown) combination of c_{ii} values where the changes in Q-ratio roots is largest may occur. This is where a bit of insight on the part of the designer is needed. A "first-guess" run can be performed using estimated limits on the c_{ii} and a delta value to give a reasonable number of data points. After a cursory examination of the preliminary data a second run with appropriately modified data could be determined.

Such a computer design program is ideal for use with an on-line, time-sharing computer terminal system. In a relatively short time the designer has a written and graphical record of results which he can later use in a full design study. In Figure 1 a flowchart of the computer program QRANGE is shown.

As discussed in [12], Kleinman's Iterative Method [13] includes a sub-routine that is a numerical technique for solving (6) for Q, given A_m and C. This is an iterative method whose results compare with the method previously discussed. By using Kleinman's method and varying c_{ii}, a range of values on the Q matrix elements can be obtained. These results then help the designer define regions in the s-plane where zero compensators of the error characteristic equation may be placed.

Whereas the other numerical methods discussed thus far were exact, the Kleinman iterative method supplies answers which are only accurate to within some tolerance. Therefore, any zero compensator placement based on results from this technique would have to be verified to insure that Q was p.d. and that (6) was n.d. However, this need not negate the use of this method, for it would be expected that only near the boundary of a stability region would the approximate iterative results differ from exact results. Computationally, it solves

$$A_m^T Q + Q A_m + C = 0$$

by starting with an a priori input initial guess and then iteratively homing in on Q to within the given tolerance. This tolerance is based on the requirement that

$$\frac{q_{ij}(k+1) - q_{ij}(k)}{q_{ij}(k+1)} < TOL \qquad i = j \tag{15}$$

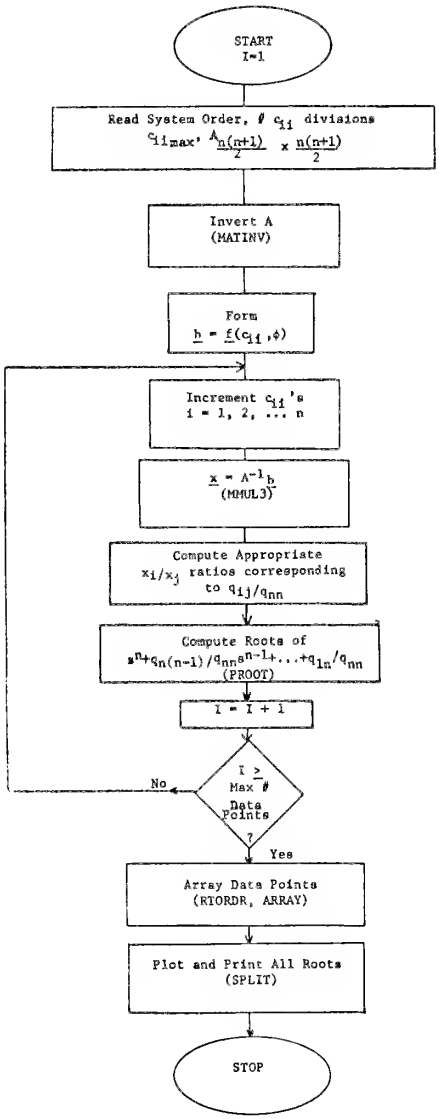

Figure 1. Flowchart of QRANGE

where (k+1) indicates the $(k+1)^{st}$ iteration. In this way TOL represents a percent error ($0 \leq TOL \leq 1$).

The A matrix given by (9) consists of a large number of zero entries with A_m in the form of (5), so it is of value to explore this matrix sparcity insofar as matrix inversion is concerned. As a relative analytical indication of the number of zero entries in A, the sparcity index SI is introduced. This is merely the fraction of zero entries in A.

For the A_m form given in (5), the number of non-zero entries is $(2n^2 - n)$ and the total number of entries $\left[\frac{(n)\quad(n+1)}{2}\right]^2$; so the index is

$$\frac{\left[\frac{n(n+1)}{2}\right]^2 - \left[2n^2 - n\right]}{\left[\frac{n(n+1)}{2}\right]^2} = \frac{n^3 + 2n^2 - 7n + 4}{n(n+1)^2}$$

$$0 < SI < 1 \qquad n > 0$$

It is clear that as n gets large, $SI \to 1$ so that A has a larger fraction of zero entries as n increases. For the case n=5, SI = 80% so it does not take long before the sparcity index approaches 100%. A matrix inversion routine utilizing the advantages of sparce matrices (SI > 80%) is given in [14] which can speed up the matrix inversion considerably.

CAD APPROACH FOR DETERMINING DESIGN PARAMETERS OF MRAS CONTROLLERS

In this section use will be made of the iterative approaches of Section III in order to show how the results can be used in designing MRAS systems with the error characteristic equation given by (4). Specifically, a straightforward technique for relating adaptation parameters to the adaptive error transient response will be given. This is part of a continuing effort to reduce MRAS controller design to its simplest terms [15, 16].

Expanding the first term in the numerator of (4) results in

$$\sum_{i=1}^{n} q_{in}s^{i-1} = q_{1n} + q_{2n}s + q_{3n}s^2 + \ldots + q_{nn}s^{n-1} \qquad (17)$$

which is a polynomial in elements of Q, specifically elements of the last row or column (since Q is symmetric). Therefore, the q_{ij} elements determine some of the zeros of (4). Rewriting (4),

$$1 + \frac{k\left[\sum_{i=1}^{n} q_{in}/q_{nn}\, s^{i-1}\right]\left[\sum_{i=1}^{p} \frac{K_i s^{i-1}}{K_h}\right]}{s\,\Delta_m(s)} = 0 \qquad (18)$$

where $k = q_{nn} K_h$, h = 1, 2, or 3 depending on the value of p (h=p). The K_i terms of (4) and (18) are of the form

$$K_1 = \alpha_{n1} x_{1m}{}^{o^2} + (\gamma_{n1})\, U_1{}^{o^2} + \ldots + (\gamma_{nr}) U_r{}^{o^2} \quad [4] \qquad (19a)$$

$$K_2 = \beta_{n1} x_{1m}{}^{o^2} + (\delta_{n2}) U_2{}^{o^2} + (\delta_{n2}) U_2{}^{o^2} + \ldots + (\delta_{nr}) U_r{}^{o^2} \quad [1] \qquad (19b)$$

$$K_3 = \rho_{n1} x_{1m}{}^{o^2} + (\sigma_{n1}) U_1{}^{o^2} + (\sigma_{n2}) U_2{}^{o^2} + (\sigma_{nr}) U_r{}^{o^2} \quad [2] \qquad (19c)$$

From (18), it is the combination of the root locus gain "k", q_{ij} ratios, and K_i gain ratios which determine the closed loop error poles. The ratios K_{i/K_j}, however, are by definition positive and can be selected so that zeroes lie anywhere in the LHP. In order to determine the effect of a set of values of K_{i/K_j} ratios, however, closed-loop error pole locations must be known. This requires a knowledge of the Q ratios in (18).

Since the Q elements must satisfy (6), the selection of K_i gains (and hence α, β, ρ, α, δ, σ terms) to effect a "best" transient error response is not clear. However, by determining sets of acceptable Q ratios and roots of (18), the designer can then determine combinations of K_{i/K_j} to yield acceptable error pole locations in the s-plane.

As a simple illustration of the expanded form of (4), for a 2nd order system of the type in [2] (p=3) with one-input, one-output, and with transfer function given by

$$G_m(s) = \frac{2}{s^2 + 2s + 2}\ ;\ G_p(s) = \frac{c}{s^2 + as + b}\ ;\ a,\ b,\ c \text{ unknown}$$

(18) becomes

$$1 + \frac{(q_{22}K_3)(s^2 + q_{12/q_{22}})(s^2 + K_{2/K_3}\, s + K_{1/K_3})}{s(s^2 + 2s + 2)} = 0$$

$$K_1 = \alpha_{21} x_{1_m}{}^{o^2} + \gamma_2 U_1{}^{o^2}$$

$$K_2 = \beta_{21} x_{1_m}{}^{o^2} + \delta_2 U_1{}^{o^2}$$

$$K_3 = \rho_{21} x_{1_m}{}^{o^2} + \sigma_2 U_1{}^{o^2}$$

constants
α, β, ρ, γ, δ, σ used in (19)

Knowledge of the (an) allowable range of values of $q_{12/q_{22}}$ is desired. By sweeping the c_{ii} elements of (12) through a set of numbers

$$\{c_{ii} | \; c_{ii} \in \Omega_1\}$$

a set of Q elements

$$\{Q | Q \in S_1\}$$

results. By sweeping the c_{ii} through a set

$$\{c_{ii} | c_{ii} \in \Omega_2\}, \; \Omega_2 \neq \Omega_1$$

then in general the resulting Q set

$$\{Q | Q \in S_2\}$$

is such that $S_1 \neq S_2$. Shown in Figure 2 is an example of such a situation. Shown are regions S_1 and S_2, representing the real number $q_{12/q_{22}}$. Region S_2 might represent the range of $-q_{12/q_{22}}$ available based on a diagonal C matrix, whereas S_1 represents the theoretical actual range (normally not known). Based on S_2, a value for $q_{12/q_{22}}$ is determined and the designer then proceeds to select K_{i/K_j}, etc. and to design his adaptive controller. If it is known $q_{12/q_{22}}$ can be selected from S_1, it simply means the designer has greater flexibility in determining acceptable K_{i/K_j} ratios. What the elemental values of C are does not matter.

Given a program such as QRANGE, plus a root locus plotting routine, a designer trained only in traditional linear systems methods could then easily design a complete adaptive controller of the types discussed in this paper.

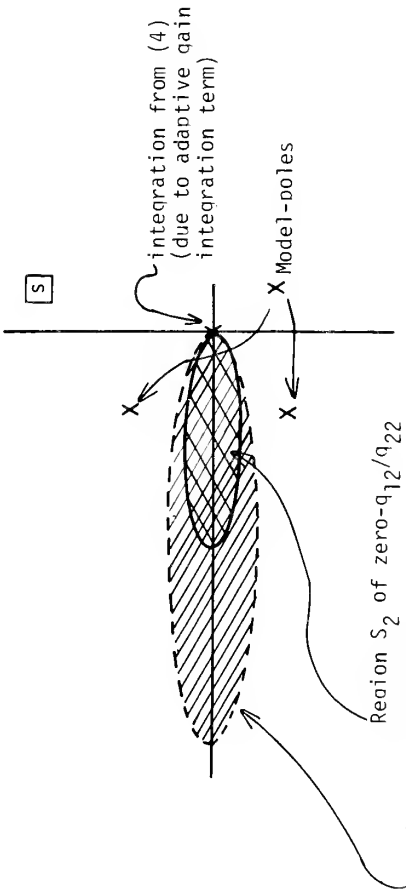

Figure 2. Variation of the possible stability bounds for $-q_{12}/q_{22}$

Order	Accuracy x 10^6	Kleinman Time (Normalized) Kleinman Time = 1.0	Proposed Technique Time (Normalized)
3	10^3	1.0	.3
	10^2	1.0	.298
	10	1.0	.297
		1.0	.289
4	10^3	1.0	.285
	10^2	1.0	.285
	10^1	1.0	.284
	1	1.0	.261
5	10^3	1.0	.272
	10^2	1.0	.262
	10	1.0	.243
	1	1.0	.214

TABLE I. Time Comparison For Computation of the Ratios q_{ij}/q_{nn}

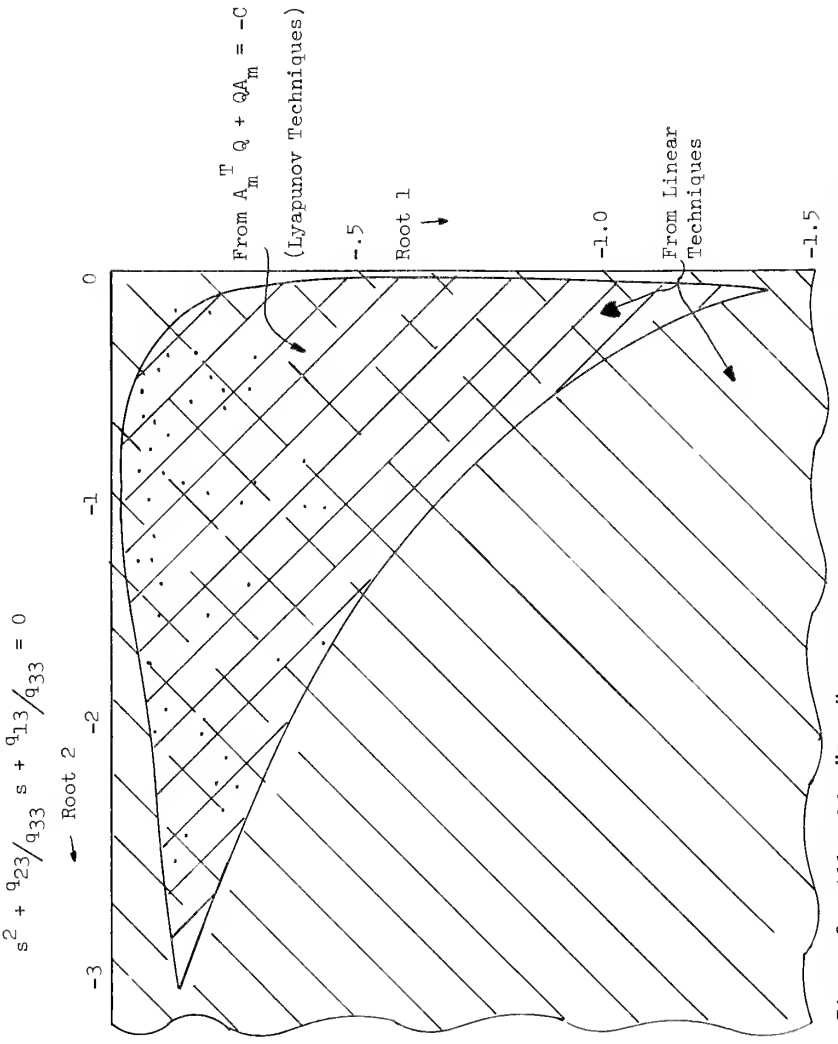

Figure 3. Allowable "Zero" Root Locations Guaranteeing Asymptotic Error Stability

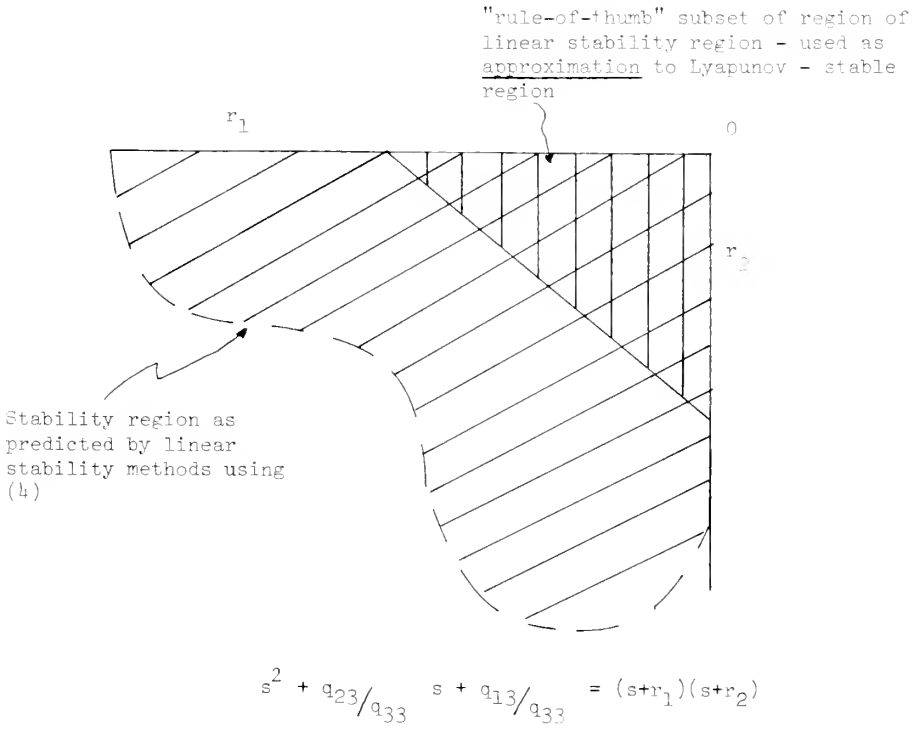

Figure 4. Illustration of Possible "Rule-of-thumb" Design Approximation Stability Region

COMPARISON BETWEEN STABILITY BOUNDS OBTAINED FROM LYAPUNOV THEORY AND LINEAR METHODS

In actual design work with model-reference adaptive systems it is necessary to use only those combinations of q_{in}/q_{nn} in (4) such that the necessary stability conditions are maintained. However, the whole purpose of the linearization technique is to reduce all the Lyapunov stability considerations to classical control techniques, especially root locus methods. It is therefore instructive to compare stability predictions between linear methods and the exact Lyapunov methods to see just how well the small-signal technique works as a design tool. Through examples, then it may be possible to develop some "rules of thumb" for various order systems as to determining how one can be a bit conservative on the stability bounds for the roots of (17) as predicted by linear methods and still meet Lyapunov requirements.

Consider the third order example

$$G_m(s) = \frac{6}{(s+1)(s+2)(s+3)}$$

Using (4), the error characteristic equation of interest (p=1) is

$$1 + \frac{k(s+a)(s+b)}{s(s+1)(s+2)(s+3)} = 0 \qquad (20)$$

Using Routh Hurwitz linear stability methods, regions of stability for "a" and "b" can be determined. Using exact Lyapunov techniques, a stability region for "a"(= Root 1) and "b"(= Root 2) placement was determined using QRANGE. The results of both the linear and Lyapunov stability regions are shown in Figure 3. For simplicity only real roots were considered here.

Some important points to note from Figure 3 are (1) as expected, Lyapunov-obtained results are more conservative than from the unrestricted linear methods which neglect the effect of the relations between Q, C, and A_m given in (6), (2) the Lyapunov stable-region is clustered near the origin with respect to linear results, (3) no part of the Lyapunov predicted region is outside that obtained from linear methods, suggesting that the Lyapunov results are a subset of linear results. In addition, it appears from both third and fourth order examples that a "rule-of-thumb" for design purposes might be that some fraction of the linear stability region centered about the origin in the root space $(r_1, r_2, \ldots r_{n-1})$, where

$$\sum_{i=1}^{n} q_{in} s^{i-1} = \left[\prod_{\ell=1}^{n-1} (s+r_\ell) \right] q_{nn} \qquad (21)$$

be used to represent the Lyapunov conditions. This is illustrated in Figure 4 for the case n=3. Results would have to be interpreted carefully, however, in order to insure stability, but as a starting point for compensation design the rule-of-thumb might be used.

QRANGE Examples

Using the proposed technique and Kleinman's Iterative Method a comparison of speed and accuracy for different order systems will be given. Arbitrary third, fourth and fifth order models were selected and various accuracies used with Kleinman's method. The results are tabulated in Table I. The actual models used were:

$$n = 3: \quad G_m(s) = \frac{6}{(s+1)(s+2)(s+3)}$$

$$n = 4: \quad G_m(s) = \frac{144}{(s+2)(s+3)(s+4)(s+6)}$$

$$n = 5: \quad G_m(s) = \frac{72}{(s+\frac{1}{2})(s+2)(s+3)(s+4)(s+6)}$$

These were arbitrarily chosen as it is felt that in most cases the actual models used would have little, if any, effect on the results. As can be clearly seen from Table I, the proposed algebraic technique is much faster than the Kleinman Iterative Method.

Shown in Figure 5 is some typical data output from QRANGE to help the designer in selection of q_{in}/q_{nn} ratios. Figure 5 illustrates the "root locus" type root location variation. Additionally a printout is available of the tabulated, ordered root combinations, representing factored zeros of (4), for each choice of c_{ii}.

SUMMARY AND CONCLUSIONS

A general algebraic technique for solving for certain q_{in} ratios used in the design of MRAS controllers has been presented and results compared with an existing technique for obtaining a parameter selection set ω for the designer to use in designing adaptive controllers.

As with the work in [2, 3, 6] it has been shown how nonlinear Lyapunov stability conditions can be reduced to the solution of a set of linear algebraic equations as given in (8) and (9). Application of this Q-ratio determination technique was given to illustrate how it is possible to require only linear design methods which an engineer versed only in the tools of classical control theory can utilize in order to design MRAS control systems.

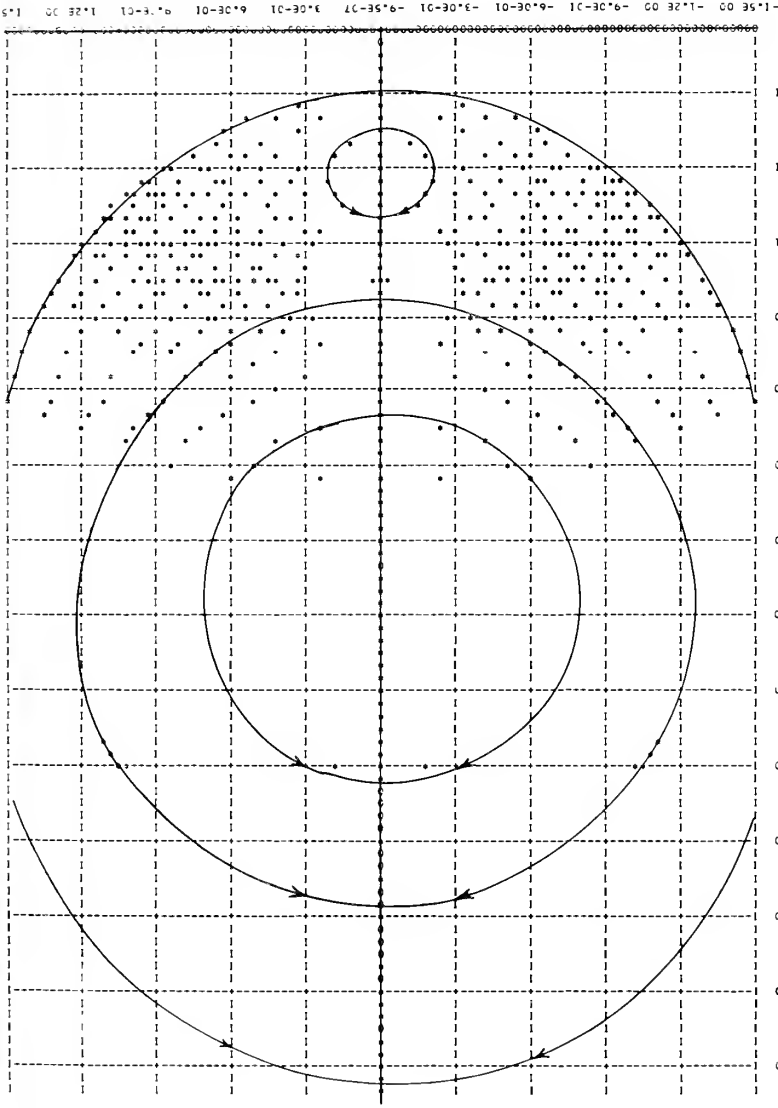

Figure 5. Zero Compensator Loci For Varying q_{in}/q_{nn} Ratio For Example

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APPENDIX

This appendix details development of a matrix A obtained from a smaller matrix A_m. In particular consider the model

$$\dot{\underline{x}}_m = A_m \underline{x}_m + B_m \underline{u} \qquad \text{(i)}$$

where

$\underline{x}_m$ is an n-vector

$\underline{u}$ is an r-vector

A_m is an nxn matrix

B_m is an nxr matrix

Using Lyapunov theory of model reference adaptive systems, the matrix equation

$$A_m^T Q + Q A_m = -C \qquad \text{(ii)}$$

occurs, where C, Q are p.d., symmetric, nxn matrices. By use of the direct matrix product [9, 18, 19], (ii) can be simplified. A modification of this, given in [7] is used here. To develop A in (9) from A_m in (7) is the desired end product.

A is of dimension $\frac{n(n+1)}{2} \times \frac{n(n+1)}{2}$. Using (K,L) and (I,J) as row and column subscripted indices, the following restrictions should be satisfied when forming the A matrix directly from A_m:

1) if K=I, L≠J, → $A_m(L,J)$
   if K≠I, L=J, → $A_m(K,I)$

2) if K≠I, L≠J,
   K=J, L≠I → $A_m(L,I)$
   K≠J, L=I → $A_m(K,J)$
   K≠J, L≠I → 0

3) if K=I, L=J

   K=J, L=I → $A_m(K,I)$
   K≠J, L≠I → $A_m(K,I) + A_m(L,J)$.

The results for a fourth order case with A_m of the form in (5) is shown in Table II.

(I-J) \ (K-L)	1-1	1-2	1-3	1-4	2-2	2-3	2-4	3-3	3-4	4-4
1-1	0	0	0	$-a_{41}^{m}$	0	0	0	0	0	0
1-2	1	0	0	$-a_{42}^{m}$	0	0	$-a_{41}^{m}$	0	0	0
1-3	0	1	0	$-a_{43}^{m}$	0	0	0	0	$-a_{41}^{m}$	0
1-4	0	0	1	$-a_{44}^{m}$	0	0	0	0	0	$-a_{41}^{m}$
2-2	0	1	0	0	0	0	$-a_{42}^{m}$	0	0	0
2-3	0	0	1	0	1	0	$-a_{43}^{m}$	0	$-a_{42}^{m}$	0
2-4	0	0	0	1	0	1	$-a_{44}^{m}$	0	0	$-a_{42}^{m}$
3-3	0	0	0	0	0	1	0	0	$-a_{43}^{m}$	0
3-4	0	0	0	0	0	0	1	1	$-a_{44}^{m}$	$-a_{43}^{m}$
4-4	0	0	0	0	0	0	0	0	1	$-a_{44}^{m}$

TABLE II. Construction of the A Matrix for the Case n=4 Using the A_m matrix in (5).

FUNGI OF ALABAMA. III. DEMATIACEOUS HYPHOMYCETES

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INTRODUCTION

Nine additional species and one variety of dematiaceous hyphomycetes collected in Alabama are described and illustrated. A number of them occur on grasses.

TAXONOMIC PART

Cercosporidium galii (Ell. and Holw.) Deighton, Mycol. Pap. 112:76, 1967 (Fig. 1).

≡ *Cercospora galii* Ellis and Holway, J. Mycol. 15, 1885.

Leaf spots conspicuous, grayish brown to brown, irregular, without a definite margin, sometimes covering most of a leaf. Mycelium immersed, composed of very pale brown or subhyaline, branched, septate, smooth-walled, 2-3μ wide hyphae. Colonies hypophyllous, punctiform, olivaceous brown. Stroma well developed, globose to subglobose, mostly immersed, pseudoparenchymatous, composed of isodiametric or somewhat elongated, thick-walled, pale to mid-brown cells; 20-56μ in diameter. Conidiophores arising from the upper, more elongate, cells of the stroma, macronematous, mononematous, densely faciculate, fascicles slightly incurved, long, flexuous, simple, continuous or septate, septa frequently faint, sometimes somewhat geniculate, pale brown, smooth, conidial scars discernible, thickened, 29-54 X 3-4μ. Conidiogenous cells integrated, terminal, polyblastic, sympodial, cicatrized. Conidia solitary, dry, straight or slightly curved, cylindrical to obclavate, very pale olivaceous brown, obtuse at apex, subtruncate at the base, smooth-walled, 0 - 1-septate, septa indistinct, 18-42 X 3-4μ

On leaves of *Galium pilosum* Ait., Forestry Plot, Auburn University, Auburn, Lee County, Alabama, 30 May 1963, K. E. Rogers, AUA; on *G. pilosum*, Cedartown, Polk County, Georgia, 7 July 1894, E. F. Andrews, AUA. Specimens obtained from phanerogamic sheets in the herbarium of Auburn University.

This fungus is probably quite common in Alabama, if not throughout the eastern United States. The type collection, by E. W. D. Holway, was made at Decorah, Iowa. It is also known to occur in Ontario, Canada (Deighton, 1967). In addition to the collections cited by him from that province, the following have been made on *Galium triflorum* Michx. (obtained from phanerogamic sheets in the herbarium of the University of Waterloo); Joe Lake, Ontario, 14 July 1929, J. F. Calvert, NMW; Sault Ste Marie, Ontario, 25 August 1970, J. Marinich, NMW.

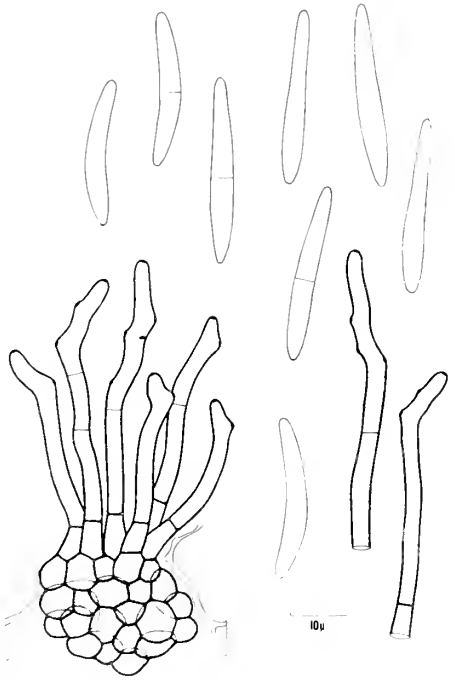

FIGURE 1. *Cercosporidium galii*

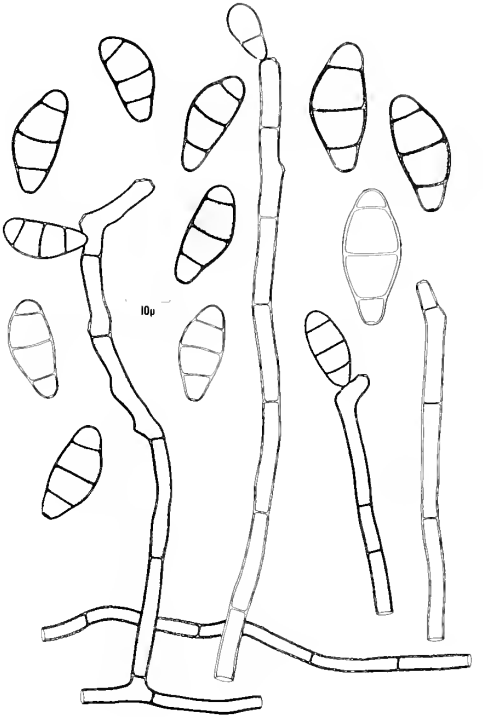

FIGURE 2. *Curvularia intermedia*

The conidiophores in the above cited specimens from Canada measure 38-57μ long and 3-4.5μ wide. The conidia measure 18-35 X 3-4μ.

The fungus has not been found on other species of *Galium* growing in North America such as *G. asperulum* Michx., *G. mollugo* L., and *G. trifidum* L. A collection on *G. mollugo* from Europe was, however, examined by Deighton.

Curvularia intermedia Boedijn, Bull. Jard. Bot. Buitenz., III, 13:126, 1933 (Fig. 2).

(*Curvularia* state of *Cochliobolus intermedius* Nelson, Mycologia 52:776, 1960).

Colonies effuse, blackish olivaceous, cottony. Mycelium immersed in the substratum, composed of branched, septate, very pale brown, smooth or irregularly verruculose hyphae, 2.5-3.5μ wide. Conidiophores macronematous, mononematous, straight or flexuous, pale brown to brown, paler towards the tip, smooth-walled, 180-450 X 4.5-7μ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial, cylindrical. Conidia solitary, acropleurogenous, simple, asymmetrial, very slightly curved, ellipoidal, 3-septate, middle septum truly median, pale to mid brown, two middle cells appreciably darker than the end cells, smooth-walled, basal hilum prominent, appearing dark, but not at all protuberant, 26-36 X 11-15μ.

On bermunda grass (*Cynodon dactylon* (L.) Pers.), Tallassee, Elmore County, Alabama, October 1974, G. Morgan-Jones, AUA.

This fungus is known mainly from *Oryza, Triticum* and *Zea* in the tropics. A previous collection of it on *C. dactylon* is familiar to the author; of unknown locality, Florida, 1963, M. O. Moss, IMI 109716. It has also been isolated from pineapple (*Ananas*), Windward Islands, 19 December 1972, A. Wallbridge, IMI 171706.

Curvularia lunata (Wakker) Boedijn, Bull. Jard. Bot. Buitenz., III 13:127, 1933 (Fig. 3).

≡ *Acrothecium lunatum* Wakker, De ziekten van het suikerriet op Java:196, Leiden 1898.

(*Curvularia* state of *Cochliobolus lunatus* Nelson and Haasis, Mycologia 56:316, 1964).

Colonies effuse, blackish olivaceous, cottony. Mycelium immersed in the substratum, composed of branched, septate, smooth or very slightly roughened, pale brown hyphae, 2.5-3μ wide. Conidiophores macronematous, mononematous, flexuous, sometimes geniculate towards the apex, frequently somewhat nodose, pale brown to brown, paler towards the tip, smooth-walled, 130-430 X 3-5μ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary,

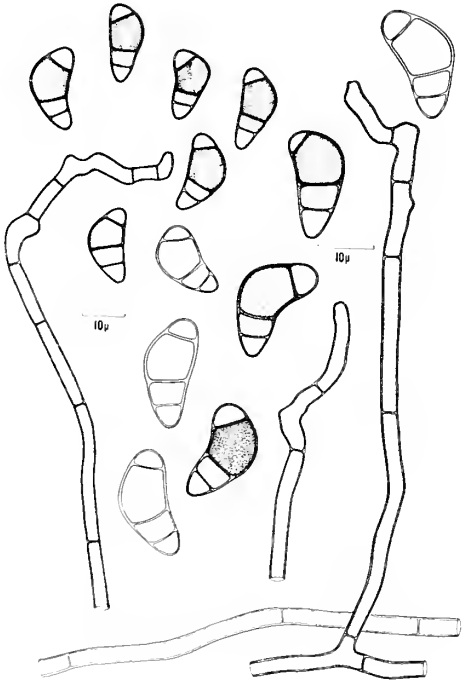

FIGURE 3. *Curvularia lunata*

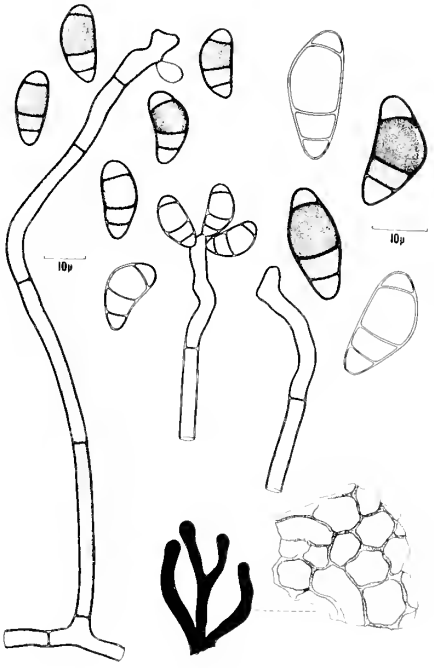

FIGURE 4. *Curvularia lunata* var. *aeria*

sympodial, cylindrical, occasionally swollen. Conidia solitary, acropleurogenous, simple, usually strongly curved, ellipsoidal to pyriform, 3-septate, smooth-walled, middle septum not truly median, pale to mid brown, second cell from the apex appreciably larger, darker and thicker walled than the others and sometimes verruculose, basal hilum discernible but not protuberant, 21-27 X 10-13μ.

Isolated from soil, Auburn Forest Nursery, Lee County, Alabama, 1 March 1974, W. D. Kelley, AUA; on *Zea mays* (vars. Funk G and Coker 77), Camden, Wilcox County, Alabama, July 1975, R. T. Gudauskas, AUA; on *Z. mays*, Fairhope, Baldwin County, Alabama, July 1975, R. T. Gudauskas, AUA.

Curvularia lunata var. *aeria* (Batista, Lima and Vasconelos) M. B. Ellis, Mycol. Pap. 106:34, 1966 (Fig. 4).

≡ *Malustela aeria* Batista, Lima and Vasconcelos, Publcoes Inst. Micol. Recife 263:7, 1960.

Characteristics similar to those of *C. lunata* except that abundant branched, erect, black, cylindrical stromata are formed in culture on potato dextrose agar. In addition the colonies of *C. lunata* var. *aeria* are distinctly zonate, in olivaceous shades, becoming much darker with age. The conidia of this isolate are more ellipsoidal than is usual in *C. lunata* and less distinctly curved, 15-28 X 9-12μ.

Isolated from crushed sclerotia of *Sclerotium rolfsii* Sacc., obtained from peanut field soil, Wiregrass Substation, Headland, Henry County, Alabama, August 1972, E. A. Wiggins and W. C. Blair, AUA.

Drechslera cynodontis (Marignoni) Subramanian and Jain, Curr. Sci. 35:354, 1966 (Fig. 5).

≡ *Helminthosporium cynodontis* Marignoni, Micromiceti di Schio: 27, 1909.

(*Drechslera* state of *Cochliobolus cynodontis* Nelson, Mycologia 56:67, 1964).

Colonies effuse, dark olivaceous, cottony. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown, smooth-walled hyphae, 3-4.5μ wide. Conidiophores macronematous, mononematous, usually arising singly, less frequently in groups, straight below, flexuous in the upper part, often geniculate, pale to mid brown, somewhat paler distally, septate, smooth-walled, 65-170 X 5-7μ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial. Conidia solitary, acropleurogenous, simple, straight or more usually slightly curved, cylindrical or ellipsoidal, obtuse at both ends, 3 to 8-septate (pseudoseptate), smooth-walled, pale to mid brown, 27-61 X 10-14μ.

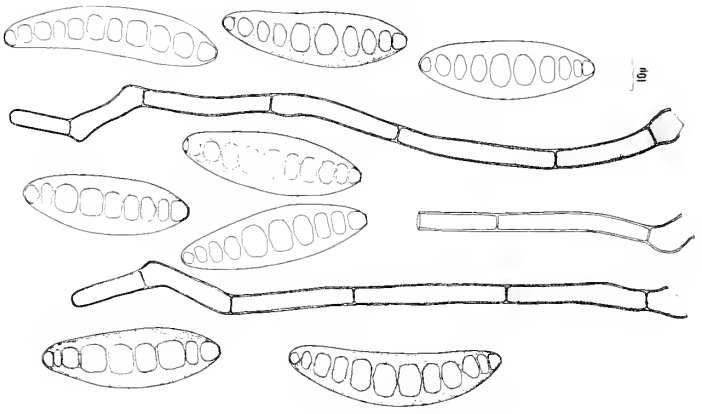

FIGURE 6. *Drechslera* state of *Cochliobolus sativus*

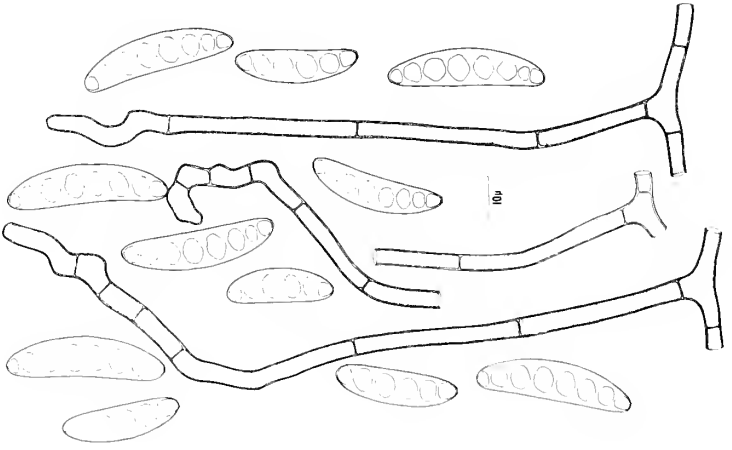

FIGURE 5. *Drechslera cynodontis*

On moldy bermudagrass hay (*Cynodon dactylon* (L.) Pers.), Autauga County, Alabama, November 1973, G. Morgan-Jones, AUA; isolated from *C. dactylon*, Tallassee, Elmore County, Alabama, October 1974, G. Morgan-Jones, AUA.

Colonies on potato dextrose agar producing abundant, floccose, olive green mycelium with some pinkish red tinge, becoming darker with age. Reverse, dark olive, sometimes with a brownish tinge, becoming blackish with age.

Drechslera state of *Cochliobolus sativus* (Ito and Kuribayashi) Drechsler ex Dastur, Indian J. Agric. Sci. 12:733, 1942 (Fig. 6).

Colonies effuse, blackish brown, hairy. Mycelium immersed in the substratum, composed of branched, septate, pale brown, smooth-walled hyphae, 3-5µ wide. Conidiophores macronematous, mononematous, arising singly or in small groups, flexuous, sometimes geniculate, pale to mid brown, paler towards the apex, septate, smooth-walled, 70-180 X 6-9µ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial, cylindrical. Conidia solitary, acropleurogenous, simple, curved, or sometimes almost straight, broadly ellipsoid to somewhat fusiform, obtuse at the apex, dark olivaceous brown, smooth-walled, 8-12 septate (pseudoseptate), 61-71 X 18-23µ.

On unidentified grass, Auburn, Lee County, Alabama, May 1974, S. P. Singh, AUA.

Periconia byssoides Pers. ex Merat, Nuov. Fl. Environs Paris, Ed. 2, 1:18-19, 1821 (Fig. 7).

Colonies effuse, black, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown hyphae, 3-4.5µ wide. Conidiophores macronematous, mononematous, scattered, erect, straight or somewhat flexuous, inflated at the base, unbranched, swollen at the apex, septate, thick-walled, cylindrical, smooth, brown, subspherical apical cell subhyaline, bearing a terminal, more or less spherical head of conidia, 210-1100 X 9-15µ, apical cell 12-13µ wide, bulbous base 12-20µ wide. Conidiogenous cells polyblastic, discrete, integrated, determinate, terminal or subterminal, subspherical or cylindrical. Conidia acrogenous, catenate, simple, globose, non-septate, brown, thick-walled, verrucose, 10-15µ in diameter.

On unidentified grass, Auburn, Lee County, Alabama, May 1974, S. P. Singh, AUA.

This fungus occurs on blackened areas and on leaf spots where it is almost invariably associated with other fungi. In this collection it is intermixed with colonies of *Epicoccum purpurascens* Ehrenb. ex Schlecht.

Periconia digitata (Cooke) Sacc., Syll. Fung. 4:274, 1886 (Fig. 8).

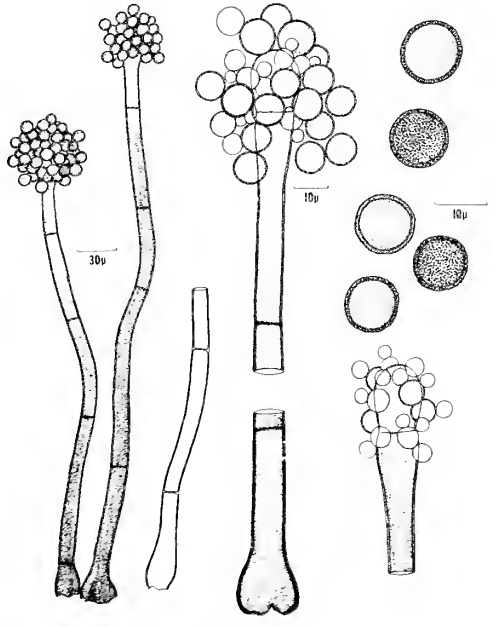

FIGURE 7. *Periconia byssoides*

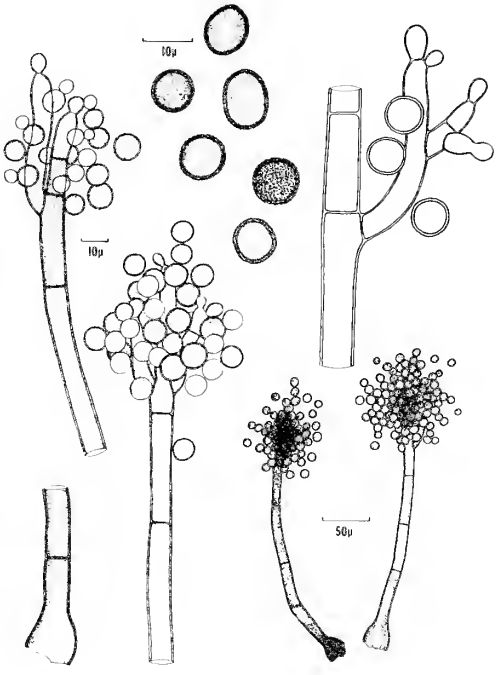

FIGURE 8. *Periconia digitata*

≡ *Sporocybe digitata* Cooke, Grevillea 12:33, 1883.

Colonies effuse, black, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown hyphae, 3-4.5μ wide. Conidiophores macronematous, mononematous, scattered or somewhat gregarious, erect, straight, branched distally, branches usually spreading, brown, thick-walled, septate, cylindrical, smooth, bearing a terminal, spherical, loosely compacted head of conidia. Stipe 280-600 X 6-14μ. Conidiogenous cells monoblastic or polyblastic, cylindrical to narrowly ampulliform, discrete at the tip of the stipe, primary and secondary branches, terminal, determinate. Conidia acrogenous, simple, globose, brown, thick-walled, echinulate to verruculose, 7-11μ in diameter.

On unidentified grass, Auburn, Lee County, Alabama, May 1974, S. P. Singh, AUA.

Phaeoisariopsis gnaphaliaceae (Cooke) Morgan-Jones, Can. J. Bot. 52:2635, 1974 (Fig. 9).

≡ *Cercospora gnaphaliaceae* Cooke, J. Linn. Soc. (Bot.) 17:142, 1880.

Leaf spots yellow to brown, irregular, frequently extending along the leaf margin or more or less covering the whole leaf, with no distinct border. Colonies effuse or orbicular, brown, hairy. Mycelium immersed in the substratum, composed of branched, septate, subhyaline to very pale brown hyphae, 3-4μ wide. Stromata largely immersed, subglobose, prosenchymatous to somewhat pseudoparenchymatous, 20-55μ wide. Conidiophores synnematous to caespitose, arising from the upper cells of the stromata, amphigenous but mostly hypophyllous, macronematous, simple, straight or flexuous, septate, smooth-walled, pale brown, paler towards the tip, sharply geniculate distally as a result of sympodial growth associated with conidiation, scars thin, 60-90 X 4-5μ. Conidiogenous cells polyblastic, cylindrical, integrated, terminal. Conidia holoblastic, solitary, dry, acropleurogenous, straight, cylindrical to narrowly obclavate, very pale olivaceous brown, smooth, three-septate, rarely two- or five-septate, obtuse at the apex, conico-truncate with a flattened scar at the base, 40-65 X 4-5μ.

On leaves of *Gnaphalium purpureum* L., Auburn, Lee County, Alabama, 21 June 1973, G. Morgan-Jones, NY, AUA.

A previous collection on the same host was made in Auburn on 20 February 1897 by F. S. Earle, NY.

Thermomyces lanuginosus Tsiklinsky, Annls Inst. Pasteur, Paris 13: 500-505, 1899 (Fig. 10).

Colonies effuse, cottony to velvety, pale olive grey to grey. Mycelium partly supercifical, partly immersed, composed of branched, smooth-walled, septate, hyaline hyphae, 1.5-2μ wide. Conidiophores

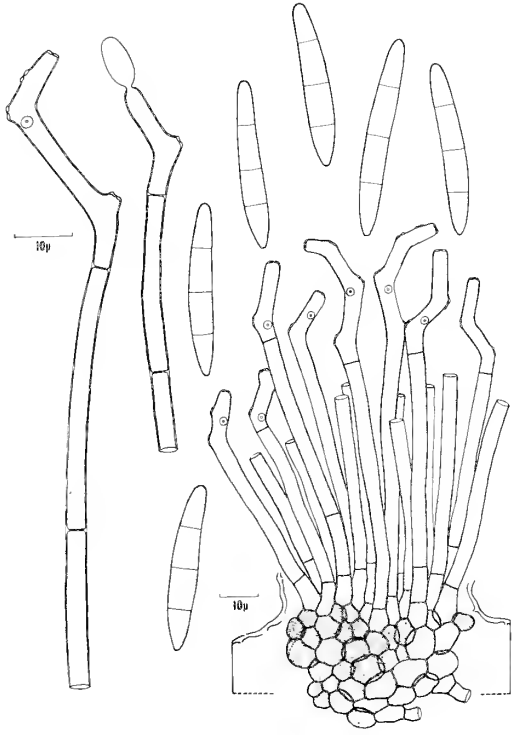

FIGURE 9. *Phaeoisariopsis gnaphaliaceae*

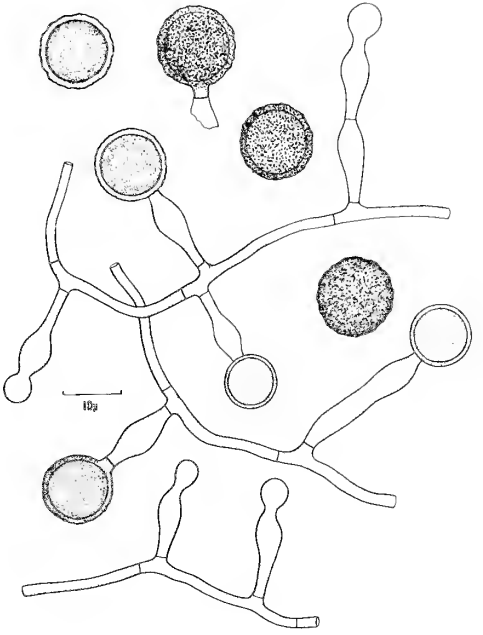

FIGURE 10. *Thermomyces lanuginosus*

semi-macronematous, mononematous, unbranched, straight or slightly flexuous, formed laterally on the mycelium, usually swollen to give a lageniform shape, hyaline, smooth, 10-15 X 1.5-2.5μ. Conidiogenous cells monoblastic, integrated, terminal, determinate. Conidia acrogenous, solitary, dry, subglobose to globose, thick-walled, dark brown, non-septate, verrucose, 6-11μ in diameter.

Isolated from seed of cotton (*Gossypium hirsutum* L.) Auburn, Lee County, Alabama, 20 February 1974, R. E. Wagener, AUA.

ACKNOWLEDGEMENT

I thank the collectors cited for allowing me an opportunity to study their material.

REFERENCES

DEIGHTON, F. C. 1967. Studies on *Cercospora* and allied genera. II. *Passalora, Cercosporidium,* and some species of *Fusicladium* on *Euphorbia.* Mycol. Pap. 112:1-80.

MARGINAL ANALYSIS AND THE ESTIMATION OF OPPORTUNITY-TIME COSTS

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INTRODUCTION

The full economic costs of attending college include not only the financial outlays of institutions and students, but the value of students' time consumed in the educational process. If one is to estimate the total economic cost, it is necessary to include an estimate of the value of the student-time consumed.

Putting resource costs aside and reckoning time-costs as simply the number of hours devoted to educational activity, "opportunity time-cost" becomes the sacrifice or reduction of time spent at other activities which accompanies the increase in time spent at educational activities. The purpose of this paper is to demonstrate a method for estimating the opportunity time-cost of educational activity. The technique is applied here to only one aspect of educational activity, the time-cost of college student travel to and from classes.

METHOD OF ANALYSIS

The basic assumption of the analysis is that persons who spend more time at a given activity must spend correspondingly less time at some other activity or activities. The goal of this demonstration is to estimate the opportunity time-cost of college student travel to class in terms of the reduction of time spent at other activities which can be associated with increased amounts of time spent traveling.

In order to accurately estimate the opportunity time-cost of an activity, it is necessary to account for all of a person's time-use. However, the data was taken from a nationwide survey that did not include questions about the amount of time students spent at leisure activity, meals, sleep, etc. Only five time-use variables were available. Therefore it was necessary to define opportunity time-cost in terms of these five "other" activities. Opportunity time-cost of travel was operationally defined as the change (reduction) in time spent at one or more of the following activities: (1) total private study time (daytime and evening), (2) gainful employment, (3) extracurricular activities, (4) time spent waiting for class to begin, and (5) daytime study on class days. All variables were defined in terms of hours per week. Students who spent little time traveling were compared to those who spent successively more time traveling, with regard to the five time-use variables. The change in time spent at these "other" activities by students who travel more could thus be recorded.

METHODS OF DATA COLLECTION

As part of a larger study, a stratified, random sample of 44 four-year institutions of higher education in the United States was drawn. A quota of lower classmen, upper classmen, and graduate students was established for each institution, depending upon its size. Bulk mailings were sent to cooperating professors or deans on each campus and multiple-choice questionnaires were administered to whole classes. Twenty-nine institutions returned a total of 3,250 usable answer sheets. Most of the questions contained ten alternative responses. This provided for considerable accuracy in the analysis of variance and multiple regression techniques which were used to analyze the data.

THE FINDINGS

An analysis of variance was run with the variable, total travel time per week "split" into ten different levels. For each of these ten groups of students, the means of the five opportunity time-cost variables were calculated. F-tests were performed to determine if differences between the ten groups' responses to each of the time-use questions were statistically significant. Table 1 presents the findings.

The basic hypothesis tested was that students who spent more time traveling to classes tended to spend less time at the five activities. All of the variables, except time spent at extracurricular activities, were significantly related to total travel time. Total travel time was defined as home-based travel time plus all other travel time, called "non-home-based travel time." This latter category included on-campus circulation.

The penultimate row of the table presents the total time spent at the four basic activities, by various levels of total travel time. Daytime study (before 6:00 p.m.) was excluded from this sum because it was already included in total study time. The bottom row of the table presents the total hours per week accounted for by all four basic activities, plus travel time.

The hypothesis that students who traveled more would tend to reduce the time spent at these activities, was rejected. One can see from the penultimate row of data that students who spent more time traveling tended to spend more time at these activities. This can be seen more clearly in Table 2, which presents the "marginal cost"[1] of travel time in terms of the five variables listed.

[1]Marginal cost of travel time was defined as the changes in time spent engaging in the five activities which were associated with a one hour change in travel time.

TABLE 1

Comparison of Mean Responses to Five Time-Use Questions by Ten Levels of Time-Use

Time Spent at Activity:	Grand Mean	Time Spent at Various Activities by Ten Levels of Travel Time(per week)									
		Under 1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9+
		(n=183)	(n=453)	(n=545)	(n=524)	(n=406)	(n=332)	(n=245)	(n=148)	(n=113)	(n=301)
T. Study (2.5)	13.4	9.4	11.6	13.1	13.1	14.3	14.6	14.6	17.4	12.3	14.5
Working (1.9)	10.3	11.1	11.8	9.8	10.0	8.5	9.9	10.1	9.6	11.6	11.7
Extracur. (1.6)	7.7	6.5	8.1	7.8	8.3	7.8	6.9	7.8	8.1	7.8	6.6
Waiting (11.2)	1.6	0.7	1.1	1.4	1.6	1.8	1.8	2.2	1.8	2.0	2.3
Day Study (5.3)	1.7	1.3	1.5	1.7	1.7	1.7	1.7	1.7	2.1	1.8	2.0
T. 1st 4[a]	33.0	27.7	32.6	32.1	33.0	34.1	33.2	34.7	36.9	33.7	35.1
4+Travel[b]	38.0	28.2	34.1	34.6	36.5	38.6	38.7	41.2	44.4	42.2	44.6

NOTES: [a]This row is the total of the first four variables.
[b]This row is the total of the first four variables plus the mean travel time (taken as mid-point of interval).

Course load was a time-use variable that was excluded from the analysis because it was thought to be a priori related to travel time per week. As it turned out, it was not ($r = .12$). Thus, it would not have influenced the above data in a consistent fashion. It would have merely raised the total time accounted for by about 14.1 hours per week. "Day Study" was excluded from totals because it is included in total study. The F-statistic follows each variable. $F = 1.88$ or larger was significant at the .05 level; and $F = 2.41$ or larger was significant at the .01 level of confidence. Total sample size was 3250. Time is in hours.

Table 2 presents the "change" in each of the five variables which was associated with a one hour "change" in total travel time. For example, comparing the changes in total study time which were associated with a one hour increase in total travel time (reading from left to right in row one), it can be seen that students who spent more time traveling to classes also tended to spend more time studying.[2] This was true of all the variables except "time spent at extracurricular activities," which had the expected algebraic sign, but was not significant at the .95 level of confidence.

CONCLUSIONS

The immediate conclusion of this analysis is that students who spent more time traveling to classes also spent more time studying, at employment, and waiting for the time when class begins. Apparently, these persons tended to stay on campus between classes, studying and waiting for their next class, rather than using the time for a jaunt home.

Second, since students who spend more time traveling to classes must reduce the time spent at some other activity, not enough time-use variables were accounted for here. What is needed is complete information on the student's total time use. Research has been conducted at several institutions where such information was gathered from a sample of students who kept activity diaries for a week. Such information, when combined with the present method of analysis should provide more complete answers to questions about the opportunity time-cost of student travel to class.

The implications of the analysis are significant. It demonstrates a technique that can be used to estimate the marginal time-costs of a variety of educational activities. For example, course-load, instead of travel time, could be the focus of time-cost analysis. Comparisons could be made among students who carry light loads and heavy loads and the marginal, opportunity time-costs could be similarly estimated.

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[2]One possible "explanation" for this is that students who spent more time traveling to classes, may also have tended to carry larger loads. However, course load was not significantly correlated with travel time ($r=.12$) or to any of the other variables, except time spent at employment ($x=-.40$). So this possibility was rejected. Likewise, the size of the city in which the schools were located was unrelated to any of the variables. (One would expect travel time to be greater in larger cities, but the number of trips per week tended to diminish as distance from school to residence increased.)

TABLE 2

The Changes in Mean Responses to Five Time-Use Questions
Between Ten Levels of Travel Time

Time Spent at Activity	Time Spent at Various Activities by Ten Levels of Travel Time(per week)										
	Grand Mean[1]	Under 1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9+
T. Study (2.5)	13.4	+2.2	+1.5	0.0	+1.2	+0.3	0.0	+2.8	-5.6	+2.2	
Working (1.9)	10.3	+0.7	-2.0	+0.2	-1.5	+1.4	+1.2	-0.5	+2.0	+0.1	
Extracur. (1.6)	7.7	+1.6	-0.3	+0.5	-0.5	-0.9	+0.9	+0.3	-0.3	-1.2	
Waiting (11.2)	1.6	+0.4	+0.3	+0.2	+0.2	0.0	+1.3	-0.4	+0.2	+0.3	
Day Study (5.3)	1.7	+0.2	+0.2	0.0	0.0	0.0	0.0	+0.4	-0.3	+0.2	
Total of first four[a]	33.0	+4.9	-0.5	+0.9	+1.1	-0.9	+1.5	+2.2	-3.2	-1.4	
Grand total[b]	38.0	+5.9	+0.5	+1.9	+3.1	+0.1	+2.5	+3.2	-2.2	+2.4	

See notes to Table 1 - same notes apply. Time is in hours.

This table is read as follows: When travel time increased from "under 1" hour to "1-2" hours per week, total study time increased "+ 2.2" hours per week.

Journal of the Alabama Academy of Science

CRAWFISH TYPE-LOCALITIES WITHIN ALABAMA

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ABSTRACT

The specifications of 23 type-localities for crawfishes which occur within the state of Alabama are given. The importance of type-localities to taxonomy is briefly discussed. Range summaries are given for those species for which type-localities are given.

INTRODUCTION

Of the 300-odd described taxa of crawfishes occurring in North America, 60 are reported to occur in Alabama, and I personally know of several yet-undescribed taxa resident there. In recent years considerable attention has been focused on "rare and endangered species" and laudable efforts have been made to protect them. Elaborate check-lists of the plants and animals of given political units have been prepared to facilitate necessary political action. Little attention, however, has been given to another aspect of scientific plant and animal study, almost as important to the professional as the perpetuation of the species. Despite some ideas to the contrary, topotypic populations retain their significant status.

Modern systematics has progressed well beyond the original designation of single or limited numbers of individuals as the basis of a species. Despite legalities imposed on nomenclature by the international codes, studies are now based heavily on variations and populational characteristics more than the peculiarities of an individual specimen. Mayr's (1969:375) statement that the type-locality is not as important for species recognition as for subspecies, although surely valid for well-known groups with limited numbers of individuals as is the case with many vertebrates (especially Mayr's birds), would not be accepted by many systematists. One would encounter disagreement particularly among those systematists working with groups still largely unknown, often ones in which the prime taxonomic characters are still being determined and their stability and reliability being evaluated. Invertebrates, which form the base of the trophic structure of the ecosystems we are trying to preserve, are largely in this latter category. Indeed, Mayr himself recognizes the importance of the knowledge of topotypic variation in his discussion of type-localities following his original statement (1969:375-77, *passim*).

I am not arguing that the same degree of attention should be given to the type-locality of a well-known and/or widely-distributed species as is given to restricted, delicately-established populations. What I do contend, however, is that topotypic populations are important to evolutionary, systematic characterizations of populations and, as such, deserve recognition and input-status when decisions are being made concerning the protection, or lack of need for it, of a particular environmental system.

In my field of expertise, crawfishes of the families Astacidae and Cambaridae, 23 type-localities exist within the state of Alabama. They are recorded below to make this information easily available to professional and lay groups interested in the environmental modifications wrought by human progress. Other specialists should make similar collations for their disciplines where they deem it appropriate. For added value, ranges of the several species are noted. This is not a taxonomic paper, and full citation of the literature for the several taxa would be out of place, but interested parties should consult Hobbs (1974) for such information; only those pertinent papers appearing subsequent to this study appear in the literature cited below.

TYPE-LOCALITIES

Family Cambaridae Hobbs

Subfamily Cambarellinae Laguarda

Genus *Cambarellus* Ortmann

C. diminutus Hobbs. Sand-bottomed stream, 3.5 miles south of Irvington, Mobile County, Alabama. Range: scattered localities in Mobile County, Alabama and George and Jackson Counties, Mississippi.

C. lesliei Fitzpatrick and Laning, 1976. 0.5 miles south of Alabama Port, Mobile County, Alabama. Range: Baldwin, Mobile and Washington Counties, Alabama and George County, Mississippi.

Subfamily Cambarinae Hobbs

Genus *Cambarus* Erichson

Subgenus *Aviticambarus* Hobbs

C. (A.) jonesi Hobbs and Barr. Cave Spring Cave, 12.1 miles northwest of Valhermosa, Morgan County, Alabama. Range: Caves in Tennessee River basin between Florence and Guntersville, Alabama.

Subgenus *Depressicambarus* Hobbs

C. (D.) obstipus Hall. Black Warrior River at Underwood's Ferry, 8 miles downstream from Cordova, Walker County, Alabama. Range: Black Warrior River drainage.

Subgenus *Erebicambarus* Hobbs

C. (E.) cahni Rhoades. Belgreen Cave (NW¼, SW¼, Sec. 12, T7S, R13W), Franklin County, Alabama. Range: known only from the type-locality.

Subgenus *Hiaticambarus* Hobbs

C. (H.) girardianus Faxon. Cypress Creek, Lauderdale County, Alabama. Range: Tennessee River drainage in Alabama, Georgia, Mississippi and Tennessee.

Genus *Hobbseus* Fitzpatrick and Payne

H. prominens (Hobbs). Roadside ditch, 3 miles west of Demopolis, on U. S. Highway 80, Sumter County, Alabama. Range: Alabama and Tennessee River drainages in Choctaw, Clarke, Dallas, Hale, Marengo, Perry, and Sumter Counties, Alabama.

Genus *Orconectes* Cope

O. alabamensis (Faxon). Second Creek, Waterloo, Lauderdale County, Alabama. Range: tributaries of the Tennessee River along the Alabama-Tennessee border.

O. australis australis Rhoades. Shelta Cavern (SE¼, NE¼, Sec. 27, T3S, R1W), north of Huntsville, Madison County, Alabama. Range: caves in Madison and Jackson Counties, Alabama north in karst caverns along western rim of Cumberland Plateau to Kentucky border.

O. compressus (Faxon). Second Creek, Waterloo, Lauderdale County, Alabama. Range: Tennessee River drainage in Alabama, Mississippi and Tennessee; Cumberland and Barren River drainages in Kentucky and Tennessee.

O. forceps (Faxon). Cypress Creek, Lauderdale County, Alabama. Range: Tennessee River drainage above Walden Gorge from Alabama to Virginia.

O. perfectus Walls. Satilpa Creek, 8.7 miles northwest of Grove Hill on Chilton Road, Clarke County, Alabama. Range: known from only five localities in Clarke and Choctaw Counties, Alabama and Clay and Lowndes Counties, Mississippi.

O. validus (Faxon). Huntsville, Madison County, Alabama. Range: Tennessee River drainage below Walden Gorge in Alabama and Tennessee, Black Warrior and Tombigbee River drainages in Alabama; may be species complex.

Genus *Procambarus* Ortmann

Subgenus *Lecticambarus* Hobbs

P. (L.) capillatus Hobbs. Drainage ditch adjacent to

Burnt Corn Creek on State Route 41 northwest of Brewton, Escambia County, Alabama. Range: Escambia River drainage in Conecuh and Escambia Counties, Alabama and Escambia County, Florida (?).

Subgenus *Ortmannicus* Hobbs

P. (O.) evermanni (Faxon). Escambia River at Flomaton, Escambia County, Alabama. Range: lower Escambia River drainage west to Jackson County, Mississippi.

P. (O.) hybus Hobbs and Walton. Roadside ditch 1.7 miles north Boligee, Greene County, Alabama. Range: middle section of Tombigbee River drainage in Alabama and Mississippi.

P. (O.) lecontei (Hagen). Mobile County, Alabama. Range: Mobile County, Alabama and Stone County, Mississippi.

P. (O.) lewisi Hobbs and Walton. Roadside ditch 18.8 miles east of Montgomery on U. S. Highway 80, Macon County, Alabama. Range: Barbour, Lowndes, Macon and Montgomery Counties, Alabama.

P. (O.) lophotus Hobbs and Walton. Roadside ditch 3.4 miles northeast of Haynesville on State Route 111, Lowndes County, Alabama. Range: upper Alabama River drainage in Alabama and Georgia; Tennessee River drainage in northwestern Georgia and Polk County, Tennessee.

P. (O.) marthae Hobbs, 1975. Small, very sluggish stream, 2.3 miles west of the Alabama River on U. S. Highway 84, Monroe County, Alabama. Range: known only from roadside ditches and sluggish streams within 1.3 mile radius of type-locality.

P. (O.) verrucosus Hobbs. Tributary of Calebea Creek, 3.9 miles south of Tuskegee on U. S. Highway 29, Macon County, Alabama. Range: Chattahoochie and Tallapoosa River drainages in southeastern Alabama.

Subgenus *Pennides* Hobbs

P. (P.) versutus (Hagen). Spring Hill, Mobile County, Alabama. Range: a species complex extending from the Black Warrior and Escatawpa River drainages in Alabama to the Apalachicola River in Florida.

Subgenus *Remoticambarus* Hobbs

P. (R.) pecki Hobbs. McKinney Pit Cave, about 2.5 miles

west of Tuscumbia, Colbert County, Alabama (Sec. 10, T4S, R12W). Range: caves in Tennessee drainage system of Colbert, Lauderdale and Morgan Counties, Alabama.

LITERATURE CITED

Fitzpatrick, J. F., Jr. and B. A. Laning. 1976. A new dwarf crawfish (Decapoda: Cambaridae: Cambarellinae) from southwest Alabama and adjacent Mississippi. Proc. Biol. Soc. Washington, 89: 134-145.

Hobbs, H. H., Jr. 1974. A checklist of the North and Middle American crayfishes (Decapoda: Astacidae and Cambaridae). Smithsonian Contr. Zool., no. 166:iii + 161 p.

Hobbs, H. H., Jr. 1975. New Crayfishes (Decapoda: Cambaridae) from the southern United States and Mexico. Smithsonian Contr. Zool., no. 201:iii + 33 p.

Mayr, E. 1969. Principles of Systematic Zoology. McGraw-Hill Book Company, New York. xi + 428 p.

ADDENDUM

Subsequent to the preparation of this manuscript, Raymond W. Bouchard and Horton H. Hobbs, Jr., (1976. A new subgenus and two new species of crayfishes and the genus *Cambarus* (Decapoda: Cambaridae) from the southeastern United States. Smithsonian Contr. Zool., no. 224:15 p.) have described a species of limited distribution from Alabama and have erected a new monotypic subgenus to receive it.

Genus *Cambarus* Erichson

Subgenus *Exilicambarus* Bouchard and Hobbs, 1976

C. (E.) cracens Bouchard and Hobbs, 1976. Short Creek at State Route 75, 1.1 miles southwest of the junction with State Route 68 (T8S, R4E, Sec. 36), Marshall County, Alabama. Range: Known only from five localities in DeKalb and Marshall Counties, Alabama, all southeastern tributaries of Guntersville Lake.

ARTICLES ON ALABAMA IN THE SCIENTIFIC AND TECHNICAL JOURNALS OF ANTEBELLUM TENNESSEE

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Austin Peay State University
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At least 19 technical or scientific journals were published in Tennessee before 1861 (Corgan, 1976). While many are too poorly known to permit an analysis of content, at least two occasionally contained articles on Alabama. These articles are here summarized in an annotated bibliography:

Currey, Richard O. 1853. Analysis of mineral waters. Southern Jour. Medical Physical Sciences, vol. 1, p. 124-126. Includes an analysis of water from Bayley's Spring in Florence, Alabama.

_____. 1854. Geology of Benton County, Alabama. Southern Jour. Medical and Physical Sciences, Vol. 2, p. 199-202. Primarily discusses a lead prospect 4 1/2 miles west of Jacksonville.

Fanning, Tolbert. 1842a. Agricultural Excursion, No. 3. Agriculturist, vol. 3, p. 49-50. Discusses crops and general agricultural conditions, mainly in Lauderdale County.

_____. 1842b. Agricultural Excursion, No. 4. Agriculturist, vol. 3, p. 97-98. As above, focused on Franklin County.

_____. 1843. Acknowledgements. Agriculturist, vol. 4, p. 127. William Butler, of Tuscumbia, Alabama, donated mastodon bones to The Geological Museum at Fanning's Elm Crag Agricultural School in Nashville, Tennessee. The bones came from northern Alabama but no precise location is provided.

To historically oriented students of Alabama geology and geography, the antebellum works of Currey and Fanning may still have academic value. They have been omitted from most comprehensive bibliographies because the journals in which they appeared are now very obscure publications.

REFERENCE CITED

Corgan, J. X. 1976. Tennessee's early technical and scientific journals, 1825-1861. Jour. Tennessee Acad. Sci., *In Press*.

INSTRUCTIONS TO AUTHORS

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Publication in the *Journal of the Alabama Academy of Science* is not restricted to members, but priority is given to material submitted by members of the Academy.

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Regular articles are published in approximate order of acceptance. Each manuscript received is sent to one or two qualified reviewers (the Editor may serve as a reviewer when subject matter is in his field), and copies of their comments and suggestions are sent to the author. Upon acceptance of a paper, the author receives a galley proof and a reprint order form.

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Since the Academy encompasses many disciplines, no standard format for manuscripts is feasible. Each author should follow the form and style of a major quality journal in the author's field. Manuscripts in the Biological Sciences may follow suggestions of the AIBS STYLE MANUAL.

Manuscripts should be double-spaced throughout (including title, footnotes, legends, literature cited, etc.) allowing 1-inch margins. The original and one copy should be submitted to the Editor. Papers which are unreasonably long and verbose, such as uncut theses or reviews, will be returned for reworking. Number all pages.

Manuscripts should be typewritten in the following order: title, author's name, author's address, summary or abstract (if author desires), text (with desired headings), acknowledgments, and literature cited.

Titles:

Make titles short but informative. Do not abbreviate.

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Authors may include a summary (abstract) with full-length articles if desired. This should come before the main body of text and should not exceed 200 words.

All abstracts of papers presented at the annual meetings will be published if submitted on time and in proper form. Such abstracts should be typed double spaced, should not include illustrated material, footnotes,

or references, and should not exceed 200 words. Abstracts should be given to the appropriate section chairman by the close of the annual Academy meeting. The chairmen will send these to the Editor.

Headings:

Use headings and subdivisions where necessary for clarity. Common headings for research papers are: Introduction (usually includes a short literature review), Procedure (or Materials and Methods), Results, Discussion, Conclusions, and Literature Cited. Others are more appropriate for certain subject matter areas. Primary headings should be in all-caps and centered on the typed page; subdivisions should be italicized (underlined) and placed at the margin.

Footnotes:

Avoid excessive use of footnotes. Where few are used, number consecutively and place at bottom of page where cited. Where large numbers are necessary, list them consecutively at the end of the manuscript under the heading, FOOTNOTES.

Illustrations:

Submit *original* inked drawings (graphs and diagrams) or clear black and white glossy photographs. Designate all illustrations as figures (abbreviate, Fig.), number consecutively, and cite all figures in text. Type figure captions on a *separate* sheet of paper. Send one extra set of illustrations for review purposes; xeroxed photographs are unsatisfactory. All illustrations will be reduced to a size not exceeding 4½ by 6½ inches. Thus, any lettering or symbols will also be reduced.

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Place each table on a separate sheet and type the caption, or title, directly above it. Number tables consecutively. Use symbols or letters, not numerals, for table footnotes. Cite all tables in the text.

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Notes

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FUNGI OF ALABAMA. IV.
TWO SPECIES OF *PSILOCYBE*

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INTRODUCTION

The temperate and subtropical vegetations of the southeastern United States from North Carolina to Florida contain elements common to the transition region into the tropical in Central America. As a result, the mycoflora is heterogenous. Such elements among the fungi include two species that have been referred to as *teonanácatl*, the "sacred mushroom" in the Aztec language of Mexico. These, *Psilocybe caerulescens* Murrill and *Psilocybe cubensis* (Earle) Singer, and several other species belonging to the hymenomycete genus *Psilocybe* (Fr.) Quélet, are hallucinogenic mushrooms used by Mexican Indians from pre-Columbian times to the present (Heim 1957a, 1957b).

P. caerulescens was first described from a collection made at Montgomery, Alabama. It has subsequently been collected at a locality in Oaxaca, Mexico. *P. cubensis*, originally described from Cuba and now known from Argentina, Bolivia, Honduras, Mexico, Trinidad and Puerto Rico, was, until recently, known to occur in the continental United States only in Florida. Davis et al.(1974) reported its occurrence in Alabama.

In this paper *P. caerulescens* is redescribed and illustrated from its type material and *P. cubensis* from recent collections made in Alabama. The latter are referred to *P. cubensis* var. *cyanescens* (Murr.) Singer and Smith.

TAXONOMIC PART

Psilocybe caerulescens Murrill, Mycologia 15: 20, 1923 (Fig. 1).

Carpophores gregarious or caespitose. Pilei campanulate, somewhat umbonate, becoming flattened with age, slightly viscid, glabrous, dark yellowish brown to chestnut, sometimes with an olive tinge when young, center dark, progressively paler towards the margin, outer third often striate, staining blue when injured, 20-70mm broad. Lamellae grey to brown, adnate, close. Stipe erect, cylindrical, somewhat enlarged at the extreme base, pruinose when young, white, darker below, 40-90 X 2-8mm. Annulus thin, white, frequently disappearing early. Pleurocystidia rare, elliptical, sometimes with a neck and resembling the cheilocystidia. Cheilocystidia abundant, elongate, lageniform to fusoid, with long necks, flexuous, 15-20 X 3-5µm necks 2-2.5µm in diameter. Basidia four-spored, 14-20 X 5-6µm. Basidiospores pale yellowish brown, ellipsoid to ovate, somewhat compressed, thick-walled, smooth, with an apical pore, 6-7 X 5-6µm.

In humus by side of stream, Montgomery, Montgomery County, Alabama, no date, R. P. Burke, N. Y.

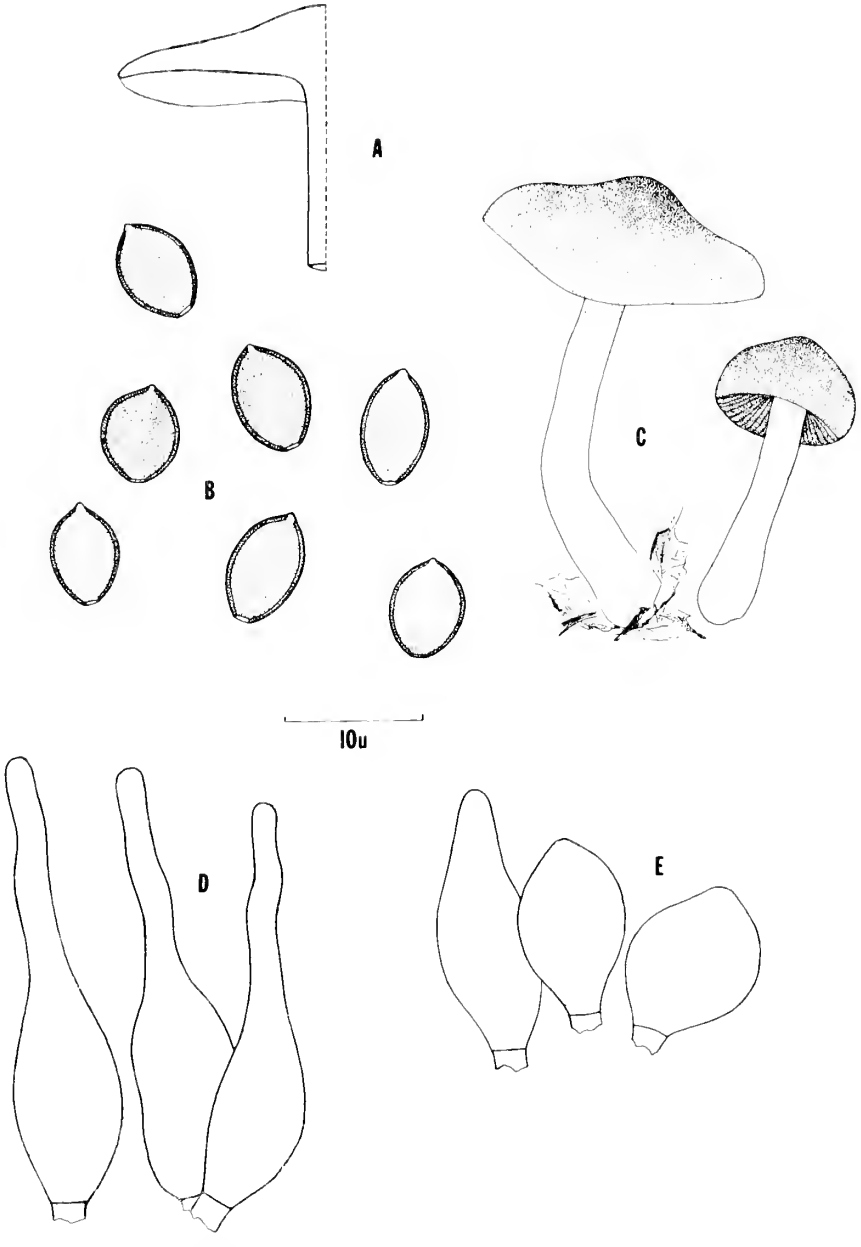

FIGURE 1. *Psilocybe caerulescens*. A, V.S. pileus; B, basidiospores; C, carpophores; D, cheilocystidia; E, pleurocystidia.

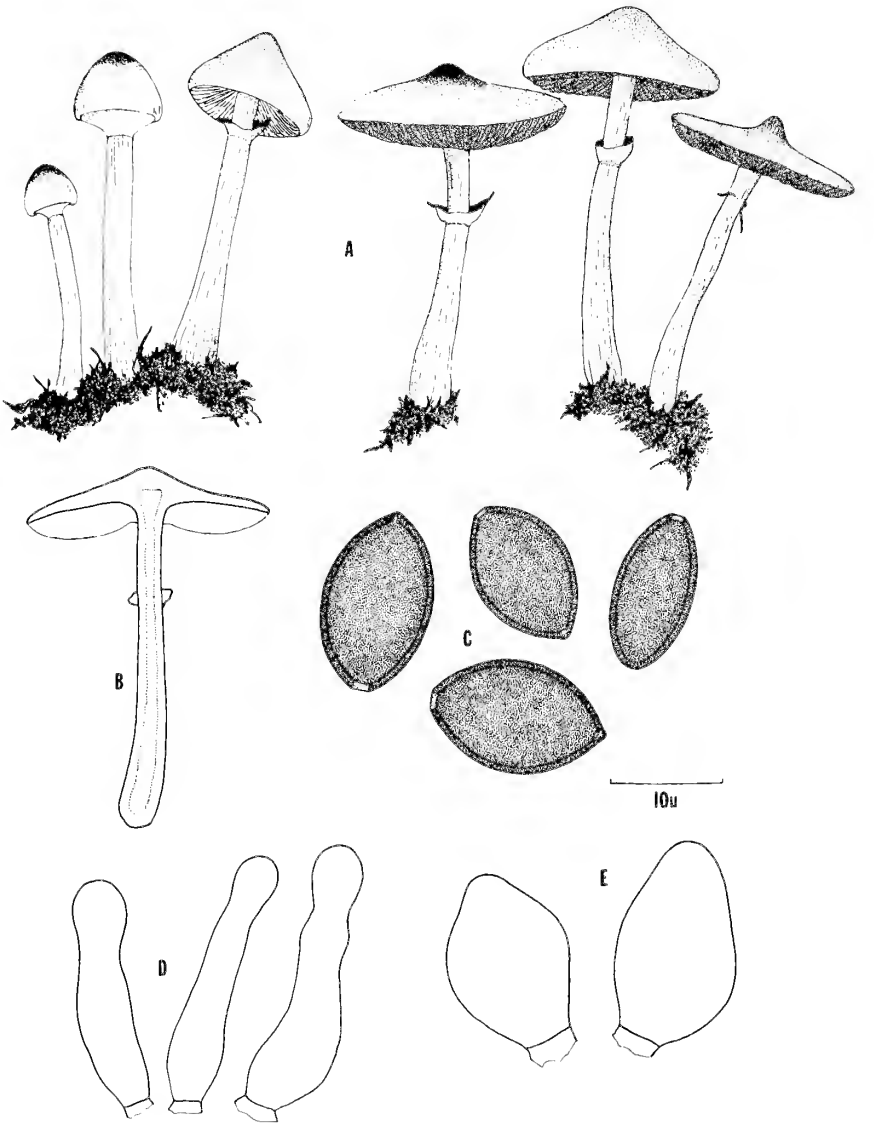

FIGURE 2. *Psilocybe cubensis*. A, carpophores; B, V.S. carpophore; C, basidiospores; D, cheilocystidia; E, pleurocystidia.

The distribution of this fungus in the southeastern United States is not known since the type collection is the only record of it other than a second collection in Mexico.

Psilocybe cubensis (Earle) Singer, Sydowia 2: 37, 1948 (Fig. 2).
≡ *Stropharia cubensis* Earle, Est. Agron. Cuba 1: 240, 1906.

Carpophores gregarious. Pilei conic campanulate, with a central papilla; papilla sometimes acute and particularly noticeable in some older specimens; becoming flattened with age, umbonate or subumbonate, or infrequently without an umbo or papilla, somewhat viscid when fresh, glabrous or with small, brownish, delicate veil remnants towards the margin, golden brown, paler towards the edge where the color is usually pale honey yellow to cream, becoming grayish brown at the margin when old, staining blue when injured, 14-90mm broad. Lamellae grayish-brown, becoming dark violet brown to black, at first mottled, adnate, close. Stipe erect, cylindrical, broader towards the base, glabrous, especially above the annulus, or minutely fibrillous, delicately grooved and white towards the apex, honey yellow below, staining bluish-green when bruised, 30-80 X 3-7mm. Annulus thin, white, smooth, fragile, persistent, but frequently disappearing, sometimes violet brown above as a result of the deposition of spores. Pleurocystidia present, swollen, irregularly ellipsoid, obtuse at the apex, 16-21 X 9-13µm. Cheilocystidia abundant, elongate, somewhat undulating, cylindrical, swollen in parts, particularly at the obtuse apex, 18-32 X 4-10µm. Basidia four-spored, 28-33 X 9-11µm. Basidiospores mid yellow brown to dark greenish brown, ellipsoid to ovate, thick-walled, smooth, subpapillate or nonpapillate at the point of attachment, apex subtruncate to trucate with a distinct pore, 13-15 X 8-11µm.

On cow dung in pasture, Wire Road, Auburn, Lee County, Alabama, 22 July 1973, N. D. Davis, G. Morgan-Jones and R. E. Wagener, AUA; on cow dung in pasture, Louisville, Barbour County, Alabama, 24 November 1973, W. Hagler, AUA.

The Alabama collections best fit var. *cyanescens* (Murr.) Singer and Smith based on *Stropharia cyanescens* Murrill described originally from Florida and now considered a nomenclatural synonym of *P. cubensis*. The pilei in this variety are rather paler than in the type variety, var. *cubensis*. The fruit bodies do, however, possess hallucinogenic properties previously reported only in the type variety but contain less psilocybin per gram of body weight (Davis et al. 1974).

It is probable that this fungus has a widespread distribution in cow pastures in the gulf states. Unconfirmed reports have indicated its presence in Georgia, Louisiana and Mississippi.

ACKNOWLEDGEMENT

I thank Dr. Clark T. Rogerson for the loan of material from the New York Botanical Garden.

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PRODUCTION OF WHEAT X RYE AMPHIPLOIDS

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ABSTRACT

Original triticales (*Triticum* x *Secale* amphiploids) were produced by using colchicine on F_1 hybrid embryo cultures. Crosses between several species of tetraploid wheat and diploid rye indicated that *Triticum durum* crossed most readily with *Secale cereale*. The latter was also a superior male parent with *T. dicoccoides* and *T. polonicum*. Tetraploid wheats varied widely in crossability with *Secale* species. Hexaploid triticale crossed readily with hexaploid (6x) wheat and octaploid (8x) triticale. Attempts to produce a tetraploid triticale by crossing diploid wheat and diploid rye failed.

INTRODUCTION

Triticale (*X Triticosecale* Wittmack), a man-made amphiploid between wheat (*Triticum*) and rye (*Secale*), is a new cereal grain with higher protein and increased amounts of two limiting amino acids, lysine and threonine. At present two types of triticale are being produced, hexaploid (2n=6x=42) and octaploid (2n=8x=56). These two triticale types differ both genetically and cytoplasmically. At present, most triticale cultivars are hexaploids. They are usually partially sterile, susceptible to the diseases of both wheat and rye, and generally have shrivelled kernels (2, 15). Many workers have found that varying degrees of cytological instability exists in both hexaploid and octaploid triticales (1, 4, 5, 6, 11, 13). Research in the School of Agriculture at Alabama A & M University is directed towards developing better triticale varieties for Alabama and the Southeastern United States (7). This goal is gradually being achieved through hydridization with newly introduced germ plasm, by selection of desirable segregates from breeding populations and by creating variability by means of physical and chemical mutagens (8). This paper presents the techniques for synthesizing triticale amphidiploids and for measuring intergeneric crossability.

MATERIALS AND METHODS

Species of wheat and rye, which had been acquired from USDA and foreign sources in 1973, were planted in 1.2 meter long single row plots during the fall of 1973 and 1974. In the spring of 1974 and 1975 these species were selected for inter- and intra-specific crossing on the basis of local adaptation and desirable agronomic characteristics.

Synthesis of New Primary Hexaploid Triticales

Four hundred thirty-one crosses were made between four species of *Secale* (male) (*S. cereale, S. montanum, S. vavilovii, S. segetale*) and

Triticum durum, T. dicoccoides, T. dicoccum, T. turgidum, T. polonicum and *T. carthlicum* (females). To overcome sterility immature triticale caryopses were collected 14 to 18 days after pollination. The embryos were removed (Plate I, A, B) aseptically and cultured on a growth medium (1) (Plate I, C). These cultures were kept in the dark at 20°C for 2 to 3 weeks until radicles emerged. Embryos were then transferred to 24 hours light until plantlets formed (Plate I, D). To double the chromosome number resulting plantlets were treated with 0.1% colchicine prepared in a 2% Dimethyl sulfoxide solution (Plate I, E). Vials remained on the treated tillers for 48 hours and were refilled after 24 hours if necessary. After treatment, seedlings were tranferred to the greenhouse and grown to maturity. Seeds from newly formed shoots were collected for verifying the chromosome numbers in these newly synthesized amphiploids (triticales) by squashing the Feulgen stained root tips of the resulting seedlings in 45% acetic acid (9).

Synthesis of New Octaploid Triticales

In order to develop desirable combinants, several 4x and 6x wheat and 2x rye species that had been selected for local adaptation and productivity were crossed in numerous combinations to determine their crossability. Crossability percent is the number of seeds set divided by the number of pollinated florets. Crosses between hexaploid *Triticum* (AA BB DD) and diploid *Secale* (RR) species were made to transfer genes for disease resistance and higher protein content from wheat cultivars 'Agent' and 'Atlas 66' respectively, and to develop new wheat/rye disomic addition lines. Octaploid triticales (AA BB DD RR) were crossed with 6x triticales to produce secondary hexaploid triticales with desirable plant characteristics. Several 4x wheat species were intercrossed to produce genetic recombinants for selection.

Synthesis of Tetraploid Triticale

Attempts were made to develop tetraploid (AARR or BBRR) triticales by crossing diploid wheat and rye species. *Triticum monococcum* (AA) was crossed in the field with several *Secale* species (*S. montanum, S. segetale, S. cereale)* in the spring of 1975. *T. spelta* was crossed with *S. anatolicum, S. segetale, S. vavilovii* and *S. montanum.* Immature F_1 seeds were collected 15-18 days after pollination for embryo culture.

RESULTS AND DISCUSSION

Combinations of wheat and rye species and the use of embryo culture techniques resulted in new primary hexaploid and octaploid triticales (Plate II, A, B). The crossability between wheat x rye species, as determined by the percentage of pollinated florets that developed functional embryos, varied with different *Triticum* and *Secale* species (Table 1). Data indicated that in 1974, *T. durum* gave the highest crossability (7.73%) with *Secale cereale* cultivar 'Snoopy.' The latter was also a good combining male parent with *T. dicoccoides, T. dicoccum,* and *T. polonicum.* On an average *T. durum* crossed best with most of the *Secale* species followed by *T. dicoccoides, T. durum, T. dicoccum* and *T.*

polonicum. The crossability between wheat x rye varied with species and cultivar used and is controlled by two genes Kr_1 and Kr_2 (1). Among the four species of *Secale* used, as pollen parents on *T. durum*, *S. cereale*, produced the best seed set, followed by *S. montanum* (Fig. 1). The sterility of these wheat x rye hybrids is generally caused by incompatibility between wheat (AABB) and rye (RR) genomes (genetic sterility), or by failure of chromosome pairing (chromosomal sterility) at meiosis. This sterility sometimes can be overcome by collecting immature triticale caryopses 14 to 18 days after pollination, and culturing them on nutrient media containing essential plant nutrients and growth hormones.

Attempts to produce octaploid triticales showed that *T. aestivum* L. (AABBDD, 2n=6x=42) crossed more readily with *S. cereale* than with *S. montanum* (Table 2). The resulting F_1 amphiploid is only partially fertile but in most cases its gametes are more functional when selfed or back-crossed to 6x triticales than to 4x wheat x 2x rye F_1 amphiploids. Selfed or embryo cultured F_1 plants, followed by doubling of the chromosome complement with colchicine, resulted in an octaploid triticale (AA BB DD RR, 2n=8x=56). These 8x triticales were usually more winter-hardy. However, they are of low fertility and late maturity. On the other hand, they usually produced plumper seeds and their bread-making quality characteristics are better than hexaploid types. At present most 8x triticales are being used to produce secondary hexaplid triticales by crossing with hexaploids and selecting 6x types in the segregating generations. To produce wheat cytoplasms with improved agronomic characteristics, two tetraploid wheats or tetraploid x hexaploid wheats were crossed (Table 3) and the F_1 backcrossed to rye to produce new triticales. In such attempts both hexaploid and tetraploid wheat cytoplasm can be used for improving adaptation, quality and disease resistance as reported by Sisodia and McGinnis (10).

The Successful production of allotetraploid triticales (2n=4x=28) by crossing diploid wheat (AA or BB or DD) with diploid rye is still problematical. Our results from such crosses are not encouraging (Table 4). If such 4x triticales could be produced, they could be used as bridge crosses to transfer genes from bread wheats and rye to hexaploid triticales (3).

Geneticists and plant breeders are interested in learning to manipulate the present genetic system of triticale to produce wheat/rye addition and substitution lines of desired chromosomal composition. Continued efforts are being made in overcoming the present problems encountered with wheat x rye hybrids such as disease, lodging and kernel shrivelling. The present status shows that considerable improvement can be made by creating genetic diversity and by making primary and secondary hexaploid triticale crosses. Balancing the nuclear and cytoplasmic system of these interspecific hybrids could be the solution for genetic fitness and stability. Such approaches are being used in the present project.

ACKNOWLEDGEMENTS

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TABLE 1 - Crossability values between tetraploid *Triticum* and diploid *Secale* species in Field, 1974.

Cross	Number of Crosses	No. of florets pollinated	Seed set as percentage of pollinated florets
T. durum x S. cereale (Insave)	8	210	0.48
T. durum x S. cereale (Snoopy)	16	440	7.73
T. durum x S. cereale (ND 324)	6	162	4.32
T. durum x S. cereale (Elbon)	3	72	0.00
T. durum x S. vavilovii	6	148	2.70
T. durum x S. montanum	14	386	3.62
T. dicoccoides x S. cereale (Snoopy)	3	58	0.00
T. dicoccoides x S. cereale (Elbon)	7	169	4.70
T. dicoccoides x S. cereale (F_3 Snoopy)	12	318	6.92
T. dicoccoides x S. segetale	4	114	0.00
T. dicoccoides x S. montanum	3	60	1.67
T. dicoccum x S. cereale (Insave)	5	135	0.00
T. dicoccum x S. cereale (Snoopy)	5	138	7.30
T. dicoccum x S. cereale (NF 324)	3	76	0.00
T. dicoccum x S. cereale (F_3 Snoopy)	7	190	2.10
T. dicoccum x S. montanum	2	56	0.00
T. turgidum x S. cereale (Rymin)	3	82	11.10
T. turgidum x S. cereale (Bonel)	6	181	4.40
T. turgidum x S. cereale (Snoopy)	1	26	0.00
T. turgidum x S. montanum	3	84	0.00
T. polonicum x S. cereale (Balbo)	2	52	0.00
T. polonicum x S. cereale (Snoopy)	4	109	3.70
T. polonicum x S. cereale (Bonel)	8	203	0.99
T. carthlicum x S. montanum	8	198	13.10
T. carthlicum x S. cereale (Elbon)	5	135	0.74

TABLE 2 - Crossability values between hexaploid *Triticum* and diploid *Secale* species in field, 1975.

Cross	No. of Crosses	No. of Florets Pollinated	Seed Sets as Percentage of Pollinated Florets
T. aestivum x S. cereale cv. Arthur cv. Rymin	1	28	7.00
T. aestivum x S. cereale cv. Blueboy II cv. Rymin	1	28	0.00
T. aestivum x S. montanum cv. Blueboy II	2	56	0.00
T. aestivum x S. montanum cv. Agent	1	28	0.00
T. aestivum x S. montanum cv. Arthur	1	28	3.00
T. aestivum x S. cereale cv. Arthur cv. Snoopy	1	28	28.00
T. aestivum x S. cereale cv. Caprock cv. Explorer	1	28	10.00
T. aestivum x S. cereale cv. Caprock cv. Dwarf Rye	1	28	21.00

TABLE 3 - Crossability values among tetraploid Triticum species in Field, 1974.

Cross	Number of Crosses	Number of florets pollinated	Seed set of percentage of pollinated florets
T. turgidum x T. durum	3	79	12.70
T. durum x T. dicoccum	3	92	19.60
T. durum x T. aethiopicum	5	139	4.30
T. aethiopium x T. durum	1	23	0.00
T. dicoccoides x T. durum	9	247	2.43
T. dicoccoides x T. turgidum	3	58	3.45
T. dicoccum x T. dicoccoides	3	83	13.30
T. dicoccum x T. durum	7	190	2.10

TABLE 4 - Crossability values between diploid Triticum and Secale species in Greenhouse, Spring, 1974.

Crosses	Genome Combination	Number of Crosses	Number of florets pollinated	Seed set of percentage pollinated florets
T. monococcum x S. montanum	AA x RR	2	50	00.00
T. monococcum x S. segetale	AA x RR	5	140	00.00
T. monococcum x S. cereale	AA x RR	4	106	00.00
T. spelta x S. anatolicum	AA x RR	4	94	00.50
T. spelta x S. anatolicum	BB x RR	2	44	00.00
T. spelta x S. segetale	BB x RR	1	24	4.17
T. spelta x S. vavilovii	BB x RR	1	20	00.00
T. spelta x S. montanum	BB x RR	1	21	00.00
T. aegilopoides x S. montanum	DD x RR	1	26	00.00

Explanation of Plate I

Synthesis of Primary Triticale:

A. Immature Triticale caryopsis showing embryo.

B. Dissected wheat x rye amphiploid embryo.

C. Wheat x rye embryo on nutrient media.

D. Wheat x rye amphiploid plantlets.

E. Colchicine treatment of amphiploid by Tiller (Capping) method.

PLATE I

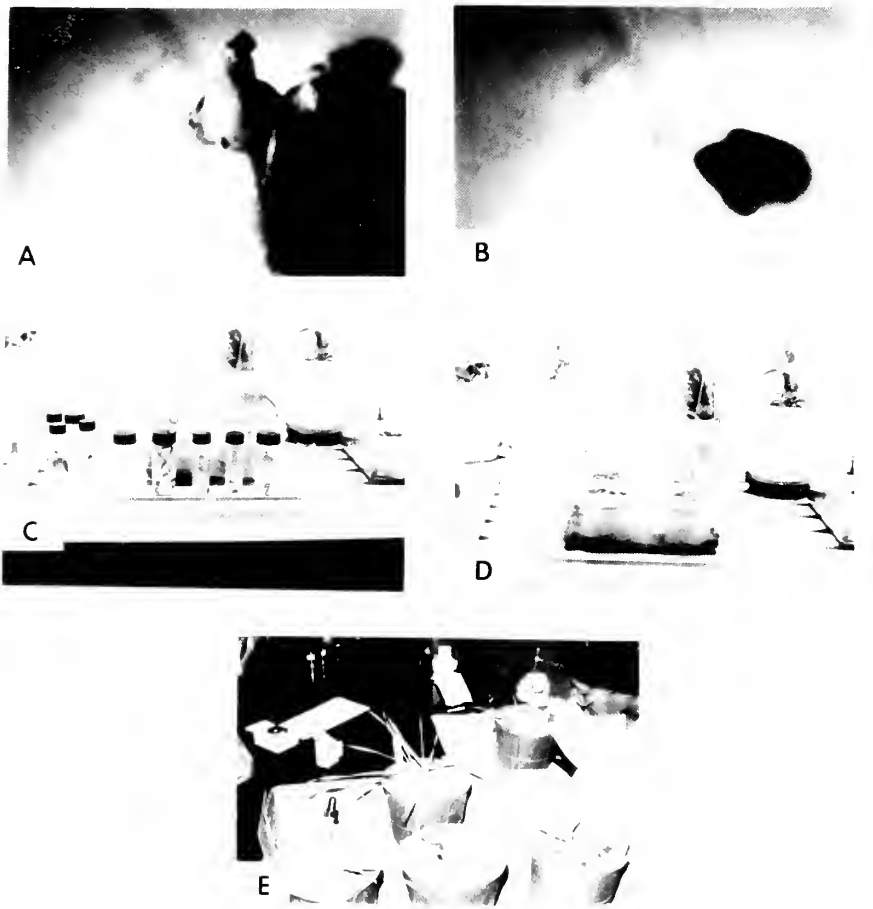

PLATE II

A

A. A hexaploid triticale cell showing 2n = 42 chromosomes

B

B. A octaploid triticale cell showing 2n = 56 chromosomes

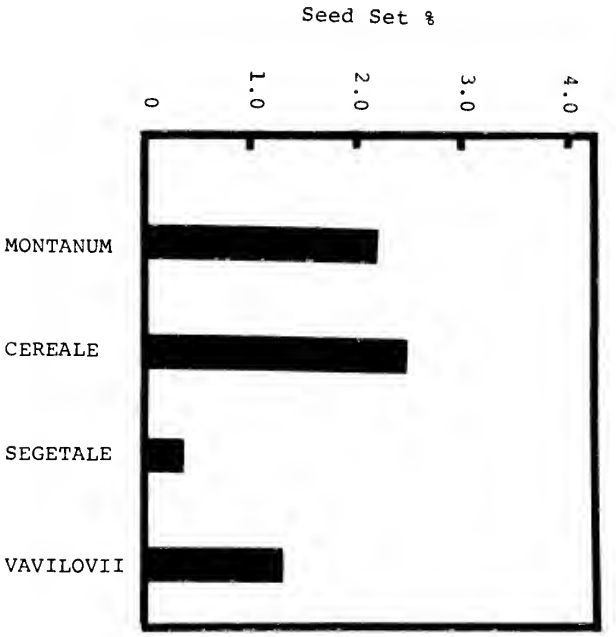

Figure 1. Seed set (%) between *Triticum durum* and four species of *Secale*.

THE MOBILE *GAZETTE* AND THE AMERICAN OCCUPATION OF MOBILE IN 1813: A LESSON IN HISTORICAL DETECTIVE WORK

Jack D. L. Holmes*

In his presidential address to the American Historical Association, the late Professor Walter Prescott Webb urged his fellow-historians to inject more humor into their writing and to relate more of their personal experiences in pursuing the "high adventure" which *is* history.[1] This lesson in historical detective work may be considered as a small memorial to a great historian.

While superlatives often fix the attention of the general public on historical events, there is a danger in using the word, "first." For example, I have published on the *first* regularly-published newspaper in the Gulf States, *Le Moniteur de la Louisiane*, which first appeared in New Orleans during 1794.[2] Apparently, the *first* known Alabama newspaper was the "Mobile *Centinel*," printed at Fort Stoddert, May 23, 1811-June 6, 1812.[3] When the *first* newspaper appeared in the Port City, however, has until now been clouded in mystery. Clarence S. Brigham's classic study of early newspapers makes the following comment regarding the Mobile *Gazette:*

> "The earliest known issues are entitled 'Mobile Gazette Extra,' dated July 23 and August 4, 1813, and published by J [ames] Lyon. But since there is no volume numbering, there is no clue to the time of establishment...."[4]

Through the use of a different set of clues, however, based on research concerning the American occupation of Mobile in 1813, this writer has discovered the date of the first issue of the Mobile *Gazette*.[5] Volume one, number 1, appeared on April 28, 1813.

Within the confines of the ancient *lonja* or market in Sevilla, Spain, are discovered millions of pages of documents referring to the history of America during the time when the sun seldom set on the Spanish Empire. One particular section contains a large number of original newspapers from the United States and France. There are also transcripts, sometimes in English but more often translated into Spanish, from early newspapers. One handwritten copy of an article translated from English into Spanish on May 13, 1813, appears as enclosure Number 7 in a group of documents which apparently had been sent by a Spanish official in the United States to his superiors in Spain.[6]

During the first century after newspapers appeared in the United States it was common practice to reprint stories from one newspaper as items in another paper. Andrew Marschalk, a pioneer printer in Territorial Natchez, had begun the Natchez *Intelligencer* shortly after the American occupation of the former Spanish District in 1798.[7] Another early newspaper was the Washington *Republican*, published in that early capital of the Mississippi Territory, located six miles north of Natchez. Although these two papers were combined in 1815 as the Washington *Republican*

and Natchez *Intelligencer,* the Washington *Republican* was separate on June 1, 1813, when it reprinted a story on the American occupation of Mobile.[8] Although it was in English, the stilted language suggests it might have been translated from a Spanish interpretation of the English original. By comparing the two accounts of the same original story in the Mobile *Gazette* it is possible to make an appraisal of this event in Alabama history.

N.º 7

In the newspaper entitled *Mobile Gazette* for 28 April 1813, Number 1, the following account is made by its editor, J. Lyon,[9] concerning the capture of Mobile by the Americans:[10]

"During the first days of the month of March, Major-general Wilkinson[11] received at his head-quarters orders for taking possession of the eastern part of Louisiana.[12] The only predictible obstacle which might have delayed the project was the presence of the enemy, who navigate these waters,[13] or the Spaniards at Pensacola, who might have learned of our plans. Thus, speed and secrecy were the essential requirements for our movements.

"The General had already assembled the troops and gathered the equipment for the expedition. Under the pretext of preserving the health of his troops, he ordered a battalion from the 3d Regiment[14] from *English Turn*[15] to *Pass Christian.*[16] Also, with the feigned object of working on fortifications under construction at *Petite Coquille,* he sent a company of artillery and a battalion of the 2d Regiment sent from New Orleans.[17] By March 26th these preliminaries were completed, and on the 27th Commodore Shaw received orders to dispatch a division of gun boats to take possession of [Mobile] Bay and cut off all communication with Pensacola.[18] Lieutenant-colonel Bowyer,[19] who had a respectable force near Fort Stoddert,[20] received his orders to be prepared to march at a moment's notice.[21]

"The General left New Orleans on the 29th [of March] aboard the schooner *Alligator* and sailed along Bayou St. John to Lake Pontchartrain by twilight of the same day.[22] At daybreak the wind died and, in order to hasten his rendezvous with the troops at *Pass Christian,* he transferred to a bark[23] which tacked back and forth against the wind opposite Petite Bais in fifteen feet of water.[24] Here he remained for some time with little hope of being aided, inasmuch as no one had noted their dangerous situation, although several ships had passed within sight of the stranded party. Finally, several Spanish fishermen discovered the stranded boat and came to the aid of the half-drowned occupants. The boat was towed ashore where it was scraped and cleaned.

"At sunset the general reboarded and by midnight had arrived at *Petite Coquille,* having made a side-wind crossing of three leagues across one arm of the lake. The troops selected for the mission passed muster the following day and embarked on April 1st for the rendezvous, being convoyed by Gunboat Number 27. This boat ran aground in the Rigolets,[25] and since it was almost sundown the general ordered the transports to proceed to

their destination by the best way possible. He left himself the following morning and by evening was stopped on *Grand Isle.*[26] He then transferred from the gunboat and boarded a sloop,[27] which brought him to the Pass by nightfall. As they were passing Bay St. Louis, Gunboat No. 22 fired two shots at them, one of which passed between the sloop's masts.

"On the morning of the 3rd he sent an express to Lieutenant-colonel Bowyer with orders to descend Mobile River and occupy the bank on the opposite side of the bay. Then after discovering that Commodore Shaw's orders had not yet been received by the gunboats assigned to the blockade (because Lieutenant Bainbridge had previously requested them to help him at the mouth of the Mississippi where he had been stranded), the general sent the armed boat *Alligator* ahead to [Mobile] Bay under the command of Mr. Shepherd, with a sergeant, corporal and twenty men.[28]

"Commodore Shaw arrived at the Pass on the 4th, and the following day he sent Lieutenant Roney to the bay with a gunboat. Everything had been prepared and completely outfitted in advance, including 30 scaling ladders.[29] The troops embarked on the 7th and sailed into a heaving sea with the wind from behind.[30] On the evening of the 8th with light winds[31] the transports passed off shore from *Pass Christian* and, after fighting against contrary winds, arrived at *Pass Herron* on the afternoon of the 10th.

"Captain Atkinson took command of a party sent for the purpose of surprising the Spanish guard and of capturing a pilot from Dauphin Island. The party completed their mission before midnight, and the following morning the Spanish corporal and six men boarded a galley bound for Pensacola.

"At ten o'clock three of the transports were still far behind. Nevertheless, the general ordered the other transports to increase their speed. Because of this, many of them ran aground repeatedly as they tried to negotiate the narrow passes. On the previous afternoon Commodore Shaw left the flotilla and headed for open sea by way of the pass between Horn Island and Petit Bois. He then cruised in Mobile Bay with the *Alligator* and Lieutenant Roney's bark and succeeded in capturing several ships, among which was a transport carrying an artillery lieutenant, a detachment of troops and provisions for Fort Charlotte. At the same time, Lieutenant-colonel Bowyer swiftly descended the Tensaw and encamped opposite the city with five bronze field cannon.

"After our flotilla entered the bay and anchored, the general held a meeting in which he discussed the various landing plans. He made the necessary arrangements and issued appropriate orders. Sails were raised, and by evening the flotilla arrived at l'Ance de Mobile. The wind calmed and the atmosphere was serene with clear moonlight and profound silence. The troops assembled on land before two o'clock. The first inkling that the Spanish commandant had of the general's approach was the sound of our men's band music which shattered the stillness of the night.[32]

"On the afternoon of the following day a column of six hundred of our men filed toward the copse of woods which faced the fort and took up their positions. At the same time, Major H. L. Pierre, the general's aide-de-

camp, carried a message to the Spanish commandant. He was ordered to surrender the town and evacuate his men. This was done on the 15th when the stars and stripes replaced the insignia of despotism amid the joyful sound of artillery salutes. This act gave incalculable joy to the Americans and to all friends of mankind."[33]

In the same newspapers there is a proclamation of General Wilkinson given when the troops had landed at *Ance a Mobile*.

"People of Mobile. Fear not what you may see. Rather, remain calm in your homes and take no part in the action which might occur when the American flag may be raised near you. I come here by order of the President to put into force the laws of the American Nation and to promulgate the civil laws of the Mississippi Territory. Public faith is a guarantee of protection for your person and property. All those who are disposed to leave the city or vicinity will be granted permission to go in safety and they may carry with them their personal effects and movable property. Given at camp, near Mobile, 12 April 1813. Signed James Wilkinson."

This is a translation of the original, which I hereby certify, Havana, 13 May 1813.

Miguel de Arambarr.[s]

The Spanish archival manuscript closed with the above translation note, but a different, more patriotic end accompanied the account appearing in the Washington *Republican*. "Let us enjoy the rich blessing," it read, "in such a manner as to prove to the world, we merit it; let us look to the mildness, the beneficence and justice of our government, and let kindness, benevolence, forbearance and charity, succeed tyranny, cruelty, injustice and persecution."[34]

A final paragraph provided a laconic news item as follows:

"We learn that colonel Carson, to whom was assigned the duty of reconnoitering the Eastern frontier of Florida [*sic*], arrived at Perdido river on the 17th inst. on the western bank of which he found a Spanish post occupied by a sergeant and seven men. He caused them to take a hasty leave of the territory of the U. States: they moved towards Pensacola."[35]

These two accounts appearing in contemporary newspapers provide an amusing description of the American expedition which took possession of Mobile and they also provide us with a clue as to when Mobile itself published its first regular newspaper. The mystery is herewith solved: the first issue of the Mobile *Gazette*---Volume One, Number One----appeared on 28 April 1813.

NOTES

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[1]Walter Prescott Webb, "History as High Adventure," *American Historical Review,* LXIV, No. 2 (January, 1959), 265-281.

[2]Jack D. L. Holmes, "The Two Series of the *Moniteur de la Louisiane,*" *New York Public Library Bulletin,* LIV, No. 6 (June, 1960), 323-328; "The *Moniteur de la Louisiane* in 1798," *Louisiana History,* II, No. 2 (Spring, 1961), 230-253; and "Louisiana in 1795: The Earliest Extant Issue of the *Moniteur de la Louisiane, Louisiana History,* VII, No. 2 (Spring, 1966), 133-151.

[3]Clarence S. Brigham, *History and Bibliography of American Newspapers, 1690-1820* (2 vols.; Worcester, Mass.: American Antiquarian Society, 1947), I, 4.

[4]*Ibid.,* I, 6-8.

[5]Jack D. L. Holmes, "Cayetano Pérez and the American Occupation of Mobile," Abstract in the *Journal of the Alabama Academy of Science,* XL, No. 3 (July, 1969), 194.

[6]This account is translated back into English below. It is found in Archivo General de Indias (Sevilla), Papeles procedentes de la Isla de Cuba, legajo 1839. Other newspapers noted from this valuable bundle include *L'Ami des Lois & Journal du Soir* (New Orleans, April 1, 1813, and February 29, 1816); *Courrier de la Louisiane* (New Orleans, October 17 and 19, 1814); Boston *Daily Advertiser* (January 8, 1816); *Columbian Centinel* (Boston), January 3, 1816; *Gazette de France* (Paris), September 4, 5, 6, 8 and 9, 1814; and the *Journal de Paris (Politique, Commercial et Litteraire),* September 1, 4, 5 and 7, 1815.

[7]On the introduction of printing in territorial Mississippi, see John Hebron Moore (ed.), "Claiborne's Journal in 'Mississippi': A Fragment from the Unpublished Second Volume of the *History of Mississippi*," *Journal of Mississippi History,* XXII (April, 1960), 88-89.

[8]The Washington *Republican* begam publication with April 13, 1813. A microfilm copy of the June 1st issue is in the newspaper file of the Mississippi Department of Archives and History (Jackson).

[9]James Lyon, the editor of the Mobile *Gazette,* was active in politics as well as journalism. Before the War of 1812 he ran for Congress from Tennessee. He was responsible for two newspapers in Vermont, five each in Tennessee, Georgia, Louisiana, Alabama and South Carolina. F. Wilbur Helmbold, "Early Alabama Newspapermen, 1810-1820," *Alabama Review,* XII, No. 1 (January, 1959), 55-56.

[10]Enclosure No. 7, in a dispatch (not found), Archivo General de Indias (Sevilla), Papeles procedentes de la Isla de Cuba, legajo 1839. The translation may have been ordered by several persons, including Luis

de Onís, the Spanish Minister Plenipotentiary in the United States (not recognized until after 1814); Brigadier Vicente Folch y Juan, the governor of West Florida at Pensacola; or even Cayetano Pérez, the beleagured commandant of Fort Carlota de Mobile, who was subsequently court-martialed for surrendering Mobile to General Wilkinson.

[11]General James Wilkinson (1757-1825), one of the most remarkable scoundrels in American hisory, had been involved in the mis-named "Spanish Conspiracy" of the 1780's and 1790's, as well as the Burr Conspiracy of 1805-1806. Rather than serving as a "double-agent" for Spain while drawing his salary as top general in the U.S. Army, he seems to have served faithfully his own best interests. The best of numerous biographies is James R. Jacobs, *Tarnished Warrior, Major-General James Wilkinson* (New York, 1938).

[12]Wilkinson received Secretary of War John Armstrong's February 16, 1813 order on March 14, while he was commanding the troops who were improving fortifications at the strategic posts below New Orleans. The order required Wilkinson to take possession "of the country west of the Perdido, and particularly of the town and fortress of Mobile," which the U.S. had claimed as part of the Louisiana Purchase of 1803. Spain, with better historical arguments, denied that any part of West Florida had been included in the Louisiana Purchase since all of British Florida had been transferred to Spain after the American Revolution and had nothing to do with France! The Spanish position is adequately expressed in Miguel Cayetano Soler to Viceroy of New Spain (José de Iturrigaray), No. 135, Aranjuez, 22 May 1805, Archivo General de la Nación (México, D. F.), Reales Cédulas section, Vol. 195, fols. 277-278. Wilkinson's account is in General James Wilkinson, *Memoirs of My Own Times* (3 vols.; Philadelphia, 1816), I, 507-508. Standard accounts of the episodes covered in the newspaper account are in Isaac Joslin Cox, *The West Florida Controversy, 1798-1813* (Baltimore, 1918; reprinted, Gloucester, Mass., 1967), 609-644; and Peter J. Hamilton, *Colonial Mobile*....(Boston, 1897), 357-363.

[13]The enemy is, of course, Great Britain during the War of 1812. On their naval activities in the Gulf see Frank L. Owsley, Jr., "British and Indian Activities in Spanish West Florida during the War of 1812," *Florida Historical Quarterly,* XLVI (October, 1967), 111-123.

[14]On the reorganization of the United States Army at this time, see Francis B. Heitman, *The Historical Register and Dictionary of the United States Army* (2 vols.; Washington, 1903).

[15]English Turn, located on the Mississippi south of New Orleans, was a six-day sail from the Gulf of Mexico. Jack D. L. Holmes, "Robert Ross's Plan for an English Invasion of Louisiana in 1782," *Louisiana History,* V (Spring, 1964), 173-174.

[16]Pass Christian was an important coastal settlement under the jurisdiction of the commandant of Mobile until 1810.

[17]Heitman, *Historical Register, passim.*

[18]Commodore Shaw had a force of between eight and nine gunboats, which also served as transports for the American troops. Wilkinson wrote, "If there be any credit due to this diminutive affair, Commodore Shaw and the navy are entitled to a full share of it...." Wilkinson, *Memoirs*, I, 508.

[19]Lieutenant-colonel John Bowyer enlisted from Virginia as a lieutenant in the 2d Infantry on 5 March 1792. His rank at this time dated from 6 July 1812. Before his honorable discharge on 15 June 1815, he held the rank of colonel of the 5th Infantry. Heitman, *Historical Register*, I, 235.

[20]Located on Ward's Bluff on the right bank of the Mobile River, four miles below its confluence with the Tombigbee and Alabama Rivers, Fort Stoddert (or Stoddard) was constructed in July, 1799 by two companies of American troops under the command of Captain Bartholomew Schaumburgh. It was situated on the frontier in Alabama near the 31st parallel which separated American territory from Spanish West Florida. See Jack D. L. Holmes (ed.), "Fort Stoddard in 1799: Seven Letters of Captain Bartholomew Schaumburgh," *Alabama Historical Quarterly*, XXVI, Nos. 3-4 (Fall and Winter, 1964), 231-252.

[21]Fort Bowyer, which was located on Mobile Point, was constructed after the successful completion of this campaign and named for the American officer. Hamilton, *Colonial Mobile*, 363.

[22]Following the completion of the Carondelet Canal in 1794, boats were able to leave New Orleans via the canal to Bayou St. John, which led into Lake Pontchartrain and via Lakes Borgne and Maurepas, arrive at the Gulf of Mexico. This was the most popular means of travel between New Orleans and the West Florida ports of Pensacola and Mobile. Jack D. L. Holmes, "Pensacola: Spanish Dominion, 1781-1821," in *Colonial Pensacola*, edited by James R. McGovern (Pensacola, 1974), 103.

[23]The manuscript has "barca" which may be translated as ferry boat, barge, boat or bark.

[24]The original manuscript has "se viró de grulla en 15 pies de agua en frente de Petite Bais y se mantuvo sobre dicha grulla por algun tiempo sin esperanzas de ser socorrido." The Spanish word, "virar," means to tack and the word, "grulla", refers to a crane. Apparently this was a technique of using a winch or crane to tie the ship in position so as to prevent it slipping or losing ground in a head wind. It is obvious that the boat was unable to proceed forward for one cause or another.

[25]Both newspaper accounts spell the word "Regulets," but it is obviously the water passage east of Lake Pontchartrain to which they refer.

[26]For a comparison of an earlier voyage along the same route, that done by frigate officer José de Evia (Hevia) in 1784, see Jack D. L. Holmes (ed.), *José de Evia y sus reconocimientos del Golfo de México, 1783-1796* (Madrid, 1968).

[27]The word, "chalupa," can mean several things. In addition to being a delicious Mexican dish, it can mean sloop, shallop, launch, light vessel, long-boat, or small canoe. The Washington *Republican* gives the less-familiar term "shallop."

[28]The Spanish version of "veinte hombres" refers to twenty men. The Washington *Republican* gives the number as twelve.

[29]In the Washington *Republican* account there is an asterisk at this point, which does not appear in the story from the Mobile *Gazette*. Below is the following reference to the asterisk: "It is proper to remark that t /h_/e ladders made at Pass Christian were as exactly fitted to the service intended, as if the walls of the fort had been measured by a ruler."

[30]The Washington *Republican* renders this as "the wind ahead." The Spanish account has "con viento por la proa," which might be translated as "with the wind toward the prow," or with the wind from behind.

[31]The Spanish phrase, "ventolinas," means light winds, but the account in the Washington *Republican* has the phrase as, "under a little shift of wind."

[32]This statement is ridiculous! At the same time when Wilkinson's troops captured the ship which was carrying provisions for Fort Charlotte from Pensacola and forced it to return from whence it had come, two artillerymen carried the news of the American expedition to Mobile's commandant, Cayetano Pérez. See his report to Mauricio de Zúñiga, San Carlos de Barrancas (Pensacola), 29 April 1813, Archivo General de Indias (Sevilla), Papeles procedentes de la Isla de Cuba, legajo 165-B.

[33]Wilkinson's "liberation" of Mobile was not as universally applauded as this editor's account would imply. Many newspapers ridiculed Wilkinson's campaign by comparing him with Napleon Bonaparte and suggesting that Wilkinson took Mobile "with gold, instead of using his sword." Luis de Onís, *Memoria sobre las negociaciones entre España y los Estados Unidos de Ameŕica*...(Madrid, 1820; 3d ed., Madrid, 1969), 92-93.

[34]Washington *Republican*, 1 June 1813.

[35]*Ibid.* The Perdido River, according to American claims, separated the rest of Spanish Florida from the Mobile District just "liberated" by Wilkinson.

THE GREAT GERMAN NAVAL LAW OF 1900: TIRPITZ VS. BEBEL

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Long before modern scholars reached the conclusion that the high seas Battle Fleet *(Schlachtflotte)*, which was planned by the imperial secretary for the German navy, Admiral Alfred von Tirpitz, was a capital threat to Anglo-German relations and the general peace,[1] August Bebel, the "shadow emperor" of the Second Reich, had rung the tocsin.

Bebel (1840-1913), the son of an impoverished non-commissioned Prussian officer, had, despite many early handicaps and lack of all higher education, become a master turner in Leipzig by 1864. There he had identified himself with the workers' cultural and educational organizations and soon acquired such a reputation for leadership that in 1867 he had been elected chairman of their national central committee. At the same time he had been elected to the North German Reichstag. He was to serve there and in the ensuing imperial Reichstag for the following forty-five years. In 1869 he and Wilhelm Liebknecht had founded at Eisenach the Social Democratic Workers' Party, which was loosely connected with Marx's First International. After the Franco-Prussian War, which Bebel had opposed, there had been no other course open to him than a gradualist, non-violent tactic for the conquest of power by the proletariat. But this tactic had made possible the amalgamation at Gotha in 1875 of the Lassallean and Eisenacher (Marxian) workers' parties. An incomparable leader of men, who knew how to direct his revolutionary temperament along practical channels, he had by 1890 successfully led his party out of the wilderness of the anti-Socialist persecution (1878-1890) to a legalized status. By then the Social Democratic Party (SPD), as it had been renamed, had become numerically the strongest political organization in the Reich. Animated by the dream of the collapse *(Kladderadatsch)* of the class state and capitalist system, Bebel in the following decade had taken the SPD ever closer to the threshold of democracy but was destined never to cross it.

To Bebel the English orientation was the guarantor of German security. Alliance with Great Britain would not only prevent general hostilities. It would also enable the SPD, which had always regarded every affirmative vote on a military defense or appropriations bill as an expression of confidence in the imperial government, to continue its principled opposition to all such measures. Yet to perspicacious observers it was beginning to be evident that Bebel's negative and exclusivist posture, in which the party majority, in expectation of the imminent collapse of the old order, had always followed him, would only be tolerated as long as Germany was not threatened by an overwhelming coalition of powers. Because he believed that the plan for a *Schlachtflotte* would decisively alienate England by offering a major challenge to her insular security,[2] Bebel took up the gauntlet that Tirpitz had cast into the Reichstag with the introduction in 1900 of his Second Navy Bill. To forestall implementation of the admiral's "plan", which could only end by driving Great

Britain into the Franco-Russian camp, Bebel was prepared to subordinate all other Social Democratic objectives, for he recognized at the outset of the long fight against the *Schlachtflotte* that it would undermine the diplomatic position of the Fatherland and force it into a struggle for survival.

The Reichstag's acceptance of the Second Navy Law was a decisive moment in the history of the German Empire and of the SPD. The Law helped to destroy prospects for an Anglo-German entente and initiated that alarming, steady deterioration of the international position of the Reich that was to compel the SPD, out of fundamental patriotism and a desire for a political future in Germany, to mollify its traditionally negative attitude towards the government and state. It was, in fact, the provocative naval policy *(Flottenpolitik)* of Kaiser William II and Admiral von Tirpitz that led the SPD to relegate ideological considerations to a secondary plane and assign primacy to foreign policy. The conviction that it was a question of "to be or not to be" for both the Fatherland and the Social Democratic movement was to be a great nationalizing influence on the SPD. *Der Primat der Aussenpolitik* in the thinking of August Bebel did more than anything else to bring about the adoption of that practical tactic of "negative integration"[3] that characterized Social Democratic behavior in the last years before World War I.

Bebel was not so naive as to believe that the Battle Fleet was merely the child of the kaiser's vanity, the by-product of a puerile "craving to create an impression at Windsor."[4] Every Social Democratic leader who had been trained in dialectical materialism regarded it as axiomatic that the kaiser was only the servile coadjutor of powerful industrial and commercial interests that, out of lust for global profits, were herding the German nation down the road of *Weltmachtpolitik*.[5] Bebel fully understood that it was not any transcending determination to perpetuate the aristocratic-bourgeois, semi-authoritarian ruling classes and their state or an auxiliary intention of crushing parliamentarism and the SPD that furnished the main impetus to *Flottenpolitik*.[6] At very most this thesis is valid only when applied to the Junker agrarian element in the parliamentary bloc that was responsible for acceptance of the Second Navy Law. But the bourgeoisie pushed the *Schlachtflotte* for all it was worth, not for the foregoing reasons or because they were desirous of removing the naval budget for long periods from control by the Reichstag, but for reasons analogous to those that motivated their British capitalist counterparts, -- namely profits from overseas trade and investments, armament contracts, and cheap raw materials.[7]

The whole shift in public interest in *fin du siécle* Germany, fired as it was by Tirpitz's adroit and chauvinistic propaganda, was away from the continent to the high seas.[8] If Bebel failed to block implementation of the first phase of the Tirpitz Naval Plan it was not because he underestimated the solidarity of the bourgeois-agrarian alliance that supported it, but because he underestimated the popularity of the fleet with the nation. He did not fully appreciate that the bulk of the populace had by 1900 come to believe that Germany's vastly expanded global interests could not be protected merely by an army and that only a powerful

fleet could in wartime secure the masses against the imposition of a hunger blockade by either the French or British navy. Manifestly the German emperor assigned priority to the building of a *Schlachtflotte* because it was popular to do so.[9]

Bebel realized that external profits were more important than the suppression of the SPD to the industrial and finance capitalists.[10] Had not Tirpitz emphasized to the kaiser in 1899 that without the deterrent of a Battle Fleet the English would "veto" directly or indirectly every German effort at overseas economic, financial or colonial expansion?[11] Convinced that for the bourgeoisie external competitive considerations were the dominant ones, Bebel soberly approached the Navy Bill of 1900 primarily from the standpoint of its impact upon the position of the Reich in the international arena. He intended to prove to Reichstag and nation that the *Schlachtflotte* would be less an asset than a huge liability. In doing so, he anticipated the judgment of many later historians. At the same time Bebel was consciously consigning an important interim Marxist goal to an inferior position. That goal was the replacement of the landed nobility by the bourgeoisie as the preeminent social element in the class state.

In stressing the *Primat der Aussenpolitik,* Bebel deliberately put the interests of the nation above those of either the SPD or the proletariat. From the standpoint of *grosse Politik* his hostility towards the Battle Fleet was inspired by four considerations, viz.: 1) The Battle Fleet would become a permanent weapon, whose evident offensive capabilities would transform England from a friend into a foe; 2) England would be driven into alliance with the French and Russians, which would tip the balance of power decisively against Germany and encourage an attack against her by France and Russia; 3) the kaiser's *Weltmachtpolitik* would divert the attention of the nation from Europe to the outer world, which would cause the all-important army to be neglected; and 4) a naval race with England would necessitate such expenditures as to push the imperial treasury towards bankruptcy.

Indubitably Bebel's opposition to the *Schlachtflotte* was also motivated by domestic considerations. From the standpoint of *Innenpolitik,* enormously increased naval expenditures would require further increases in indirect taxes.[12] which would prejudice the interests of the working classes. Acceptance of the Tirpitz Plan by the Reichstag would amount to a waiver of parliamentary control over a fleet that would be self-perpetuating and naval increases which would become automatic.[13] Lastly, defeat of the Second Navy Bill would probably involve the disintegration of the unstable *grosse Sammlung* of industrialists and agrarians, which had been built up in the Reichstag by the Prussian minister of finance, Johannes von Miquel.[14] But none of these considerations was allowed to rank with those of foreign policy in Bebel's thinking. The rupture of the alliance between the agrarians and industrialists, between the *Bund der Landwirte* and the *Centralverband deutscher Industrieller,*[15] was less important as a goal in the class struggle than as a stratagem to block construction of a risk Battle Fleet which must aggravate Germany's rapidly deteriorating diplomatic position.

Axiomatic to Bebel's foreign policy perspective was an unquenchable hatred of despotic Russia.[16] More prudent and realistic than Tirpitz, August Bebel, reasoned that an Anglo-German alignment would be a *noli me tangere* for the Franco-Russian Alliance, but that to implement the Tirpitz Plan would be to destroy English friendship for good. Conversely an Anglo-German partnership would abruptly put an end to the inclination of Foreign Minister (and, after 1900, Chancellor) Count Bernhard von Bülow "to follow in the wake of Russia," which, to Bebel's mind, was "the most fateful and perverse thing that can befall us."[17] Curiously there was in this respect no fundamental difference between the views of Bebel and Friedrich von Holstein, the principal counselor in the foreign office. Holstein deplored Bülow's bellicose allusions to England and his disposition "always and only to yield wherever Russia was concerned, and only there."[18] No less than Bebel, Holstein was convinced that the Second Navy Bill, if passed, would gravely damage Anglo-German relations.[19]

In his speeches before the Reichstag Bebel insisted that there were "no serious differences that would prevent Germany and England from collaborating," while, on the other hand, England's suspicions and naval dispositions were still chiefly directed against the French and Russians.[20] He argued that an Anglo-German alignment was an idea that should not be rejected out of hand because of fear of Russia's reaction. Such an alliance, linking the British fleet, "the greatest in the world," with the German army, "the best on the European mainland," would be invincible.[21] To achieve that alliance Bebel was prepared to tread hard on Russia's corns. He recommended to the Reichstag that Germany also strive for an alliance with Japan, which was the friend of England and the foe of Russia.[22] In the back of Bebel's mind was another calculation: just as Bismarck's association with Russia had had a brutalizing influence on Germany, alliance with England would now have a liberalizing influence and bring closer to realization the egalitarian socialist society of the future (Bebel's famous *Zukunftsstaat*).[23]

In his campaign against the Naval Bill of 1900, which the government laid before the Reichstag on December 11, 1899, Bebel sought to demonstrate that there was no correlation between the volume of the external trade of the Reich and the size of its navy.[24] While chiding Tirpitz, the president of the newly founded Navy League *(Flottenverein)*, for betraying the promise he had made in 1898 not to bring in a second navy bill for six years,[25] Bebel also accused bourgeois pressure groups, such as the *Alldeutscherverband, Centralverband deutscher Industrieller, Kolonialgesellschaft,* and *Flottenverein,* of preparing to barter away Anglo-German amity for the sake of private gain.[26] But regardless of the gravamen of Bebel's navy speeches, they were all motivated by an abiding concern for the security of the Fatherland, which he did not think could possible be attained by pointing the guns of a *Schlachtflotte* at England.

In December 1899 Bebel told the Reichstag that he feared the security of the Reich might have been compromised by incontinent public utterances of the emperor, especially those of January 18, 1896 and October 18, 1899.[27] In the first, William II had affirmed in Berlin that Germany had become a world market and must henceforth pursue *Weltmachtpolitik,* in

support of which she would need a large fleet. In the second, made during a speech at Hamburg when many Germans were angry over the Boer War, he stressed that the future of the Reich lay on the water and that "we bitterly need a strong German fleet" to defend vital overseas interests and support the imperial government's global policies. After these initiatives Tirpitz, further encouraged by jingoist propaganda of the *Flottenverein*, had thrown caution to the winds and caught hold of the imperial coat tails.[28] There was scarcely any doubt, averred Bebel, that the efforts of the secretary for the navy were backed by all the major capitalistic interest groups. "In South Germany alone," said he, "no fewer than eighty firms have the strongest interest in passing this navy bill, because they are closely identified with it."

All the determined efforts of Bebel and his comrades did not avail to prevent parliamentary acceptance of the Second Navy Bill, which became law on June 12, 1900. The statute proposed to double the size of the fleet and convert it from a coastal defense, cruiser force to an offensive-defensive battleship navy. Capital ships were henceforth to be built at an average tempo of 2.8 annually between 1901 and 1917, which, it was expected, would result in a decisive alteration of the battleship ratio with the British fleet from 1:2 to 2:3.[30] The success of Admiral von Tirpitz was due to several factors: the capitulation of the army general staff to the admiralty; the voting strength of the agrarian-industrialist alliance in the Reichstag; demands of unemployed shipyard workers for jobs; public indignation over British seizure of three German steamers at Delagoa Bay in December 1899 on suspicion of carrying contraband to the Boers; and, above all, the fact that a great navy elicited wide-spread enthusiasm among liberals and democrats because the bourgeois fleet harmonized with the idiom of the age.[32]

In rejecting the Second Naval Law, Bebel argued that the force requested in the law of 1898 was all that was needed to protect the German coast from invasion. Now, however, Tirpitz wanted to be able to interdict enemy vessels from both the Baltic and North seas, a task that would require a German Battle Fleet twice the current strength. Such a fleet would be potentially offensive[33] and, moreover, exceed the financial capability of the Reich. Besides this, the bill would fortify the class position of the heavy industrialists and finance capitalists in their struggle with the nobility for the mastery of Germany. The Socialists would have no part of Tirpitz's scheme, said Bebel inasmuch as it

> would strengthen a system that we are fighting, because it is demended by a government in which we repose no confidence, because the means to be employed . . . could better be employed for more worthwhile . . . purposes, and because the funds are to be raised in a manner that would always evoke our most emphatic protest.[34]

Bebel warned that this law would be followed by more requests for further alarming naval increases.[35] Stating that the Tirpitz Plan could undermine Germany's security, Bebel said:

> All speeches and discussions support the conclusion that . . . we are setting out to build a fleet that will be strong enough to engage in open battle the world's largest navy -- the British. That is the goal towards which we are steering! This must be stated unequivocally so that the German people and everyone present here may know how things stand.[36]

Subsequent events were to justify Bebel's censure of the "incomprehensible frivolity" of the big navy advocates who, while committing Germany to an intolerable financial task, were vigorously rubbing the fur of the British lion the wrong way. After the passage of the Second Navy Law the British Admiralty concentrated its attention upon what promised to be the fastest growing and most dangerous fleet of any continental power, namely the German.[37] The navalists were dooming their country to the fate of Sisyphus Germany would never be able figuratively to roll the stone up the mountain. She would "never be able to build a fleet that can match the British," predicted Bebel. Even in the event of the implementation of the Second Navy Law and assuming no acceleration of British shipbuilding, Germany would only have 17 battleships as compared with 69 British, 39 French, and 24 Russian.[38]

Bebel's line of attack was to demolish the asseveration that a *Schlaehtflotte* was a commercial and industrial imperative[39] and to insist that the *Schlachtflotte,* condemned to permanent, pronounced inferiority to the British fleet, would not even be able to secure Germany's global interests in wartime let alone smash the English home fleet.[40] On the other hand, his argument ran, the *Schlachtflotte* would devour the treasury' revenues and end by wrecking the structure of German politics.[41] Far from compelling England to respect Germany or grant her an equal "place in the sun", the *Schlachtflotte* would drive the British admiralty to devise naval operational plans against the Reich.[42] Worst of all, the Tirpitz Plan would antagonize England, force her to sue at the Franco-Russian counter, and encourage Paris and St. Petersburg "to conquer Germany and win back at relatively small cost what they have been trying in vain to regain for decades."[43] For Bebel, such a policy was that of a *Vabanquespieler,* who, by betting everything on one turn of the roulette, was flirting with tragedy for the Second Empire.

Although Chancellor von Bülow in March 1900 had finally admitted that the fleet was being augmented so as to ensure against the possiblity of war with England,[44] Bebel did not conclude from that that Bülow desired war or had abandoned hope of composition with England. Bebel did not seriously question Bulow's pacific intent, --only his ability to preserve the peace. Believing that the perils associated with Tirpitz's "risk policy" were out of all proportion to expected benefits,[45] Bebel in June 1900 scored the secretary for the navy again for having deceived the public. Quite certain of the fact that it had not been out of a feeling of empathy for bourgeois *Weltmachtpolitik* but, *ex necessitate rei,* out of desperate determination to keep the wolf from their door, that the agrarians wooed by the promise of high agricultural duties, had acceded to Miquel's *Sammlungpolitik,* Bebel henceforth strove to aggravate the tensions that plagued the industrial-agrarian alliance.[46] Cognizant that the Conservatives under no circumstances wanted to provoke England, he hammered home

the point that "any German minister who would dare to invite war with England on whatsoever pretext would be assuming the most grievous responsibility imaginable."[47] On the other hand, Bebel mocked the contradiction in a governmental policy which, while purporting to advance the interests of German commerce, aimed at concluding protective tariff agreements that must seriously injure it.[48] Because the industrialists and merchants had, as the quid pro quo of their unholy alliance with the agrarians, promised agricultural capitalism protection against foreign grain imports,[49] the masses would be burdened with higher prices for bread and meat,[50] while it was very likely that they would have to foot the great bulk of the expenditures for the *Schlachtflotte*. Bebel's prospects of ultimate success in the battle against Tirpitz and the navalists rested to some degree too upon his calculation that the bourgeois fleet could be regarded as a powerful weapon in the struggle of the middle class for domination in the ruling alliance with the nobility.[51]

Bebel's most effective order of battle after acceptance of the Second Naval Law was to argue that if a *Schlachtflotte* really was an imperative for the ruling classes, it ought not to be built with revenues from tariffs and excise taxes (such as upon coffee, brandy, tobacco, butter, salt, cocoa, sugar and other necessities or basic amenities), because these fell heaviest upon the lowest social strata. Nor should the Battle Fleet be financed in part by direct income taxes levied by the *Länder* governments because that would encourage inequities and revive political decentralization.[52] If the *Schlachtflotte* actually was inescapable, it should, said Bebel, be built with revenues from direct imperial taxes, which would have the advantages of transferring much of the burden to the rich and of strengthening the Reich government. It would have the added merit of striking the Junkers, who from the beginning had been lukewarm towards a bourgeois fleet that was of no earthly use to them. The logic behind this oblique line of attack upon the Battle Fleet and the class alliance behind it rested upon the assumption that the agrarian capitalists, half-ruined by a prolonged agricultural crisis, would, out of fear of inheritance and property taxes, soon conclude that they had more to fear from middle class aggrandizement than from the rising proletariat. Exposed to the pressure of direct taxes, the bourgeois-agrarian alliance would eventually break.

For nine years after the passage of the Second Navy Law the nation was irrevocably committed to implementing the Tirpitz Plan. This had disastrous results for Anglo-German relations. When finally the last vision of an Anglo-German alliance had faded and been replaced by the harsh reality of the Anglo-French Entente of 1904 and the Anglo-Russian Entente of 1907-1908, Bebel's vaticination was confirmed. Germany's direct challenge to British naval supremacy had driven England into close partnership with France and Russia.

In the first few years after 1900 Bebel fought against the protective tariff,[53] the quid pro quo that had been promised the agrarians in return for their venial support of the *Schlachtflotte*. Bebel's opposition to high duties was inspired by both a desire to spare the masses unpardonable increases in the cost of living and to avoid further provocation to the English. When the fight against the tariff turned into another defeat for

the SPD, Bebel admonished the Reichstag that war sentiment was rapidly rising in Great Britain, where, in any case, the public had long been convinced that German naval armaments were directed against England.[54] At the same time Bebel harped on the theme of the deepening isolation of the Reich and (after 1907) the alarming improvement in Russia's diplomatic situation.[55]

While such warnings certainly helped shift public attention towards the needs of the German army, it was the dreadnought battleship race, beginning in 1907, that afforded Bebel his last chance of exploding the Tirpitz Plan. From 1907-1912 the ailing Bebel exploited the facts of spiralling naval costs and diminishing German continental security to convince the agrarian (Conservative and Centrist) Reichstag deputies that the Reich neither could nor should strive to have both a first class fleet and army. Bebel hoped to force the lower house to make a choice, for if it did he knew that the agrarians would renounce their alliance with the National Liberals.[56]

In his purpose to destroy the Bülow Bloc of Conservatives, National Liberals and Centrists, which had been the principal support of the Tirpitz Plan, Bebel's highest trump was direct taxes, which after 1906 not even the imperial ministry cared wholly to resist.[57] His continuing agitation for inheritance and property taxes ultimately made it impossible for the bulk of the Reichstag deputies to refuse all tax reform demands. Thus it was that Bebel's oblique assault at least helped to erode the Bülow Bloc. Abandoned by the agrarians (Conservatives, Centrists, Poles and their *Bund der Landwirte* and *Bauernbund* supporters), the Bloc went to pieces between 1908 and 1909.[58] For Bebel it was a Pyrrhic victory. In reality Heaven had favored the winning side, Bebel the lost. He had failed to block the naval *Novelle* of 1908, which envisaged the building of from three to four battleships (dreadnoughts) annually until 1911.[59] The German Battle Fleet continued to be a capital menace to England's insular security.[60]

At the same time an ugly dilemma was shaping up for the SPD. Chancellor von Bethmann Hollweg was moving closer towards accommodating the Socialist demand for broad, direct taxes, which the SPD had always approved of on principle. On the other hand, proceeds from contemplated direct taxes were to be used to finance armaments, and the SPD had always rejected every military budget on Marxist principle. In this dilemma Bebel and the SPD majority inclined towards acceptance of direct taxes regardless of their purpose. It helped to dispose the party favorably towards this choice that Bethmann was quite evidently sincere in his efforts to woo England and enlist her cooperation in concerted moves to avert general war. Large naval and army budgets would only sabotage these efforts and accelerate the drift towards an Armageddon that would probably destroy the Bismarckian creation and the SPD too.

To avoid the tragedy of general war, Bebel, a mortally stricken man in 1911-1913, deliberatedly skirted treason. In confidential talks with the British consul in Zurich he strove indirectly to instill into the Asquith government such fears respecting German intentions that Britain would be stampeded into launching a crash program to achieve early, over-

whelming naval supremacy.[61] This was Bebel's "last Mohican." He fatuously hoped that absolute British naval superiority would convince the German government and admiralty that it was hopeless to continue the race any longer.[62] Surrender would soon assuage British fears and promote reconstruction of the bridge between London and Berlin.

Bebel won a last skirmish with Tirpitz over the naval *Novelle* of 1912.[63] For financial, political and international reasons the admiral had been obliged to strike his colors to the army general staff. His contemplated third squadron was temporarily restricted to battleships of pre-dreadnought design,[64] while for the first time in more than a decade appropriations for the army were sharply increased, Nevertheless, the stark truth was that essential modifications to the Tirpitz Plan had come too late to reverse the consolidation of the Triple Entente. All of Bebel's efforts, therefore, were gold thrown into the sea. On the other hand, in view of Bethmann's concessions to the SPD on the tax issue and his strenuous attempts at rapprochement with England, there was by 1913 only one option left to the Social Democracy: a party that expected to have any future in Germany must rally around the flag. As the beaten Bebel, who died in August, 1913, ruefully admitted: "There is not a man in Germany who will abandon the Fatherland to external attack."

FOOTNOTES

[1]E.g., see Rudolf Stadelmann, "Die Epoche der deutsch-englischen Flottenrivalität," *Deutschland und Westeuropa* (Schloss Laupheim, 1948), pp. 104, 137 and 140-42; W. Schüssler, *Weltmachtstreben und Flottenbau* (Witten, 1956), p. 22; Ludwig Dehio, *Germany and World Politics in the Twentieth Century* (New York, 1959), p. 81; Gerhard Ritter, *Staatskunst und Kriegshandwerk*, II: *Die Hauptmächte Europas und das wilhelminische Reich 1890-1914* (Munich, 1960), pp. 181 and 195; Volker Berghahn, *Der Tirpitz-Plan. Genesis und Verfall einer innenpolitischen Krisenstrategie unter Wilhelm II* (hereafter cited as *Der Tirpitz Plan*) (Düsseldorf, 1971), p. 185; idem, "Zu den Zielen des deutschen Flottenbaus unter Wilhelm II," *Historische Zeitschrift* (hereafter cited as *HZ*), 210 (1970): 64-66, 68, 70-71; and Peter Padfield, *The Great Naval Race. The Anglo-German Naval Rivalry 1900-1914* (New York, 1974), pp. 43 and 90.

[2]E.g., see Bebel's remarks in the Reichstag: *Verhandlungen des Reichstags. Stenographische Berichte* (hereafter cited as *VR*), 9th legislative period, 3rd session, II (March 19, 1895), 1580-85; 4th sess., II (February 13, 1896), 940-45; March 18, 1896, p. 1543; 5th sess., III (March 26, 1898), 1787-91; and 10th leg. per., 1st sess., IV (December 12, 1899), 3315-23.

[3]This phrase was first employed by Guenther Roth in his *The Social Democrats in Imperial Germany. A Study in Working - Class Isolation and National Integration* (Totowa, N. J., 1963), pp. 8, 312, and315-316 but was systematically elevated into the leitmotif of Social Democratic practice by Dieter Groh in his *Negative Integration und revolutionärer Attentismus. Die deutsche Sozialdemokratie am Vorabend des Ersten*

Weltkrieges (Frankfurt a. M., Berlin and Vienna, 1973).

[4]The phrase is from Hermann Kantorowicz, *The Spirit of British Policy and the Myth of the Encirclement of Germany*, trans. by W. H. Johnson (New York, 1932), p. 452. Cf Alfred von Tirpitz, *Erinnerungen* (Leipzig, 1919), p. 50. Not even Chancellor Chlodwig zu Hohenlohe Schillingsfürst would swallow the myth that the Battle Fleet could be ascribed simply to the domineering will or the caprice of the kaiser. See *Memoirs of Prince Chlodwig of Hohenlohe Schillingsfürst*, ed. by Friedrich Curtius, II (New York, 1906), 486-87.

[5]Bebel's historical materialist viewpoint has been widely reflected in modern literature on this subject. E.g., see Berghahn, *Der Tirpitz Plan*, p. 550; and Friedrich Forstmeier, "Der Tirptizsche Flottenbau," *Marine und Marinepolitik im kaiserlichen Deutschland 1871-1914* (hereafter cited as *Marinpolitik*, ed. by the Militärgeschichtliches Forschungsamt (Düsseldorf, 1972), p. 35.

[6]This was a main thesis developed by Eckart Kehr in his classic *Schlachtflottenbau und Parteipolitik 1894-1901* (hereafter cited as *Schlachtflottenbau*) (2nd ed.; Berlin, 1970), pp. 210-46, and in a number of articles that have been reprinted in *Der Primat der Innenpolitik. Gesammelte Aufsätze zur preussisch-deutschen Sozialgeschichte im 19. und 20. Jahrhundert* (hereafter cited as *Primat der Innenpolitik*), ed., by Hans-Ulrich Wehler (2nd ed.; Berlin, 1970).

[7]Instructive in this context are the reports of the chairman of the British Imperial Industries Club, printed in the London *Times*, March 5, 1901 and February 25, 1902. Similarly allusion is made to the profit motives of vested industrial and ship-building interests in connection with debates in Commons on the awarding of naval contracts, in Arthur J. Marder, *The Anatomy of British Sea Power. A History of British Naval Policy in the Pre-Dreadnought Era, 1880-1905* (hereafter cited as *Anatomy*) (New York, 1940), p. 37.

[8]Berghahn, *Der Tirpitz Plan*, p. 18. Thus Friedrich Naumann, the progressive National Social leader, wrote in 1900: "Who desires overseas markets must also be for a navy" (*Demokratie und Kaisertum* [Berlin, 1905], p. 217).

[9]Cf Berghahn, "Zu den Zielen," *HZ*, 210: 81.

[10]Cf Kehr, *Schlachtflottenbau*, pp. 34-35 and 210 et passim, where it is asserted that the cardinal goal of the pressure groups supporting the Battle Fleet was profit from overseas mercantile and industrial operations. On the other hand, Kehr thought that the government's reactionary *Sammlungpolitik* was designed to enlist agrarian, industrialist, and finance-capitalist elements for the purely negative aim of combatting the SPD in the Reichstag (*ibid.*, p. 146).

[11]Tirpitz, *Erinnerungen*, p. 167.

[12]See Bebel's remarks in *VR*, 10th leg. per., 1st sess., VI (February 10, 1900), 4010.

[13]This argument was most cogently presented years later by Bebel in his great plea of 1911 for the establishment of parliamentary control over the armed forces and foreign policy (*ibid.*, 12th leg. per., 2nd sess., CCLXVIII (November 9, 1911), 7723-30.

[14]While it is true, as Helga Nussbaum points out, that the material economic and socio-ideological viewpoints of the Progressives (*Freisinnige Volkspartei* and *Freisinnige Vereinigung*) frequently harmonized with those of the National Liberals (*Unternehmer gegen Monopole: Uber Struktur und Aktionen antimonopolistischen bürgerlichen Gruppen zu Beginn des 20. Jahrhunderts* [Berlin-East, 1966], pp. 152-54), the instability of the *Sammlung* derived in no small part, as Hans-Jurgen Puhle has insisted, from the circumstance that the *Sammlungpolitik* was closely tied in with the social reform program of the formerly radical Miquel and the Progressives, a program that encountered the hostility of the Conservatives, when not the National Liberals (*Agrarische Interessenpolitik in der wilhelminischen Gesellschaft* [Hanover, 1966], pp. 158-59).

[15]Q.v. Puhle, p. 159.

[16]Q.V. William H. Maehl, "German Socialist Opposition to Russian Imperialism, 1848-1891," *The New Review. A Journal of East European History*, 12, No. 3 (1972): 3-24.

[17]Bebel's remarks in *VR*, 9th leg. per., 4th sess., II (February 13, 1896), 942-44.

[18]See Norman Rich, *Friedrich von Holstein, Politics and Diplomacy in the Era of Bismarck and Wilhelm II*, II (Cambridge, 1965), 608-09.

[19]*Ibid.*, pp. 590, 611, 613.

[20]*VR*, 9th leg. per., 4th sess., II (March 18, 1896), 1543. At this time British naval plans and dispositions were still based on the assumption that in the next war the British fleet would have to fight the French and Russian navies in the Mediterranean and at the Dardanelles (Marder, *Anatomy*, pp. 172, 247-48, 274, 277; and idem, *From the Dreadnought to Scapa Flow: The Royal Navy in the Fisher Era, 1904-1919*, I (London, 1961), 106.

[21]*VR*, 9th leg. per., 4th sess., II (February 13, 1896), 945; and *ibid.*, March 18, 1896, p. 1543.

[22]*Ibid.*, 10th leg. per., 1st sess., IV (December 12, 1899), 3323.

[23]Bebel's colleague, Wilhelm Liebknecht *(Der Alte)*, had stated the cultural case for an Anglo-German alignment even more strongly. See Liebknecht's speeches in *ibid.*, 9th leg. per., 4th sess., VII (March 26, 1897), 5280; and *ibid.*, 5th sess., III (April 27, 1898), 1985, as well as his article, "Zur Weltlage," *Vorwärts* (Berlin) August 13, 1897.

[24]*VR*, 10th leg. per., 1st sess., IV (December 12, 1899), 3317.

[25]*Ibid.*, Cf Manfred Rauh, who cites Tirpitz to the effect that the kaiser had left him no alternative to following his imperious insistence upon bringing in a second navy bill (*Föderalismus und Parlamentarismus im Wilhelminischen Reich* [Düsseldorf, 1972], p. 221).

[26]*VR*, 10th leg. per., 1st sess., IV, 3319. According to Paul Kennedy, the Krupps alone contributed as much-money towards Tirpitz's navy as did the imperial government ("The Second Navy Law of 1900." *Militärgeschichtliche Mitteilungen*, 1 [1970]: 36.

[27]*VR*, 10th leg. per., 1st sess., IV, 3318.

[28]*Ibid.* Before William's Hamburg speech both Hohenlohe and Admiral Hollmann had questioned whether there was sufficient public support to warrant introducing a second naval bill, and Hohenlohe had warned that its defeat would amount to "a personal humiliation for the monarch himself" (J. David Fraley, "Government by Procrastination: Chancellor Hohenlohe and Kaiser William II, 1894-1900," *Central European History*, 7, No. 2 [1974], 169-70).

[29]*VR*, 10th leg. per., 1st sess., IV, 3319.

[30]*Ibid.*, p. 3317. The new law contemplated establishing for the "danger period" two squadrons of active and two of reserve warships (*Der Tirpitz Plan*, p. 243). Envisaged were two battleships per year for the first phase of building (1900-1904) and three per year (the *Dreiertempo*) in the second (1904-11). For the third phase (1912-17) an average of three and one half keels per year were to be laid down (*ibid.*, p. 171).

[31]Kehr, "Klassenkämpfe und Rüstungspolitik im kaiserlichen Deutschland," *Primat der Innenpolitik*, p. 102.

[32]Idem, "Die deutsche Flotte in den neunziger Jahren und der politisch-militärische Dualismus des Kaiserreiches," *ibid.*, p. 129.

[33]Cf Berghahn, who contends that it was Tirpitz's fixed idea to draw the British Home Fleet out into an attack upon the German fleet and that Tirpitz thought that the outcome of such a battle would decide the fate of Germany for decades to come. Even with a 2:3 disadvantage, the *Schlachtflotte*, the chief of the imperial Naval Office believed, would have a chance of victory (*Der Tirpitz Plan*, p. 185; "Zu den Zielen," *HZ*, 210: 64-66, 68, and 707-71).

[34]*VR*, 10th leg. per., 1st sess., V (February 10, 1900), 4010.

[35]*Ibid.*, pp. 4011-12.

[36]*Ibid.*, p. 4011.

[37]Marder, *Anatomy*, pp. 456-60. Conversely, Padfield avers that the British "Lords of the Admiralty were little more impressed than they had been by the First Law" (*The Great Naval Race*, p. 94).

[38]*VR*, V (February 10, 1900), 4015-18. Tirpitz knew that as respects numbers, tonnage displacement, and artillery caliber even the most powerful German battleships under construction in 1900-1901 (Wittelsbach-Wettin class) or to be built in 1903-1906 (Braunschweig-Preussen-Deutschland class) were inferior to British ships of the line of the Admiral and other classes (K. Assmann, *Deutsche Seestrategie in zwei Weltkriegen* [Heidelberg, 1957], p. 16). But what Bebel inadequately understood was that Tirpitz felt that it would be possible to compensate for these deficiencies by stressing efficiency, better training of personnel, structural quality, and superior tactics. Se Berghahn, *Der Tirpitz Plan*, p. 429.

[39]See Bebel's speech in *VR*, 10th leg. per., V (March 1, 1900), 4380.

[40]*Ibid.*, February 10, 1900, pp. 4013, 4015-18, 4020-22. This critical incapability was early reaffirmed by Hans Herzfeld in his "Der deutsche Flottenbau und die englische Politik," *Archiv für Politik und Geschichte*, 6 (1926): 98.

[41]*VR*, February 10, 1900, pp. 4018-19.

[42]Cf Marder, *Anatomy*, pp. 456-58. Tirpitz (*Erinnerungen*, p. 167) had argued that a big navy was the way to oblige England to respect Germany and accord her maritime parity in the outer world.

[43]*VR*, 10th leg. per., 1st sess., VII (June 6, 1900), 5817.

[44]Q.v. Lerchenfeld memorandum of March 29, 1900, cited in Rauh, *Föderalismus und Parlamentarismus*, p. 227.

[45]*VR*, VII (June 6, 1900), 5817.

[46]*Ibid.*, pp. 5819-20. See also *ibid.*, V (February 10, 1900), 4010; *ibid.*, sess., I (November 19, 1900), 2026; *ibid.*, November 23, 1900, pp. 127-28; *ibid.*, II (February 15, 1901), 1371-75 and 1378-82; and *ibid.*, March 16, 1901, pp. 1917-19. Bebel was reiterating here what he had said earlier respecting the nefarious bilateral deal of the capitalist agrarians and industrialists that underlay the new *Weltmachtpolitik*. His judgment is still regarded as convincing. See Hans-Ulrich Wehler, *Krisenherde des Kaiserreichs 1871-1918: Studien zu deutschen Sozial- und Verfassungsgeschichte* (Göttingen, 1970), pp. 163-81.

[47]*VR*, VII (June 6, 1900), 5817.

[48]*Ibid.*, p. 5820.

[49]*Ibid.*

[50]*Ibid.*, June 7, 1900, pp. 5850-51.

[51]This is the basic reason for differing attitudes within the *grosse Sammlung* towards Tirpitz's *Flottenpolitik*. That the agrarian-industrialist

alliance was much less stable than Kehr had supposed has been demonstrated in recent years by Puhle (*Agrarische Interessenpolitik*, pp. 148-49, 155-64) and by Helmut Kaelble (*Industrielle Interessenpolitik in der wilhelminischen Gesellschaft* [Berlin, 1967] p. 146).

[52]Bebel's view here was typical of practically the whole leadership of the SPD. See Hanns Macimilian Calmann, *Die Finanzpolitik der deutschen Sozialdemokratie 1867-1914* (Munich, 1922), pp. 123-24.

[53]Erich Mattias and Eberhart Pikart, *Die Reichstagsfraktion der deutschen Sozialdemokratie 1898 bis 1914*, Part I (Düsseldorf, 1966), No. 61, p. 57. The Social Democratic offensive against the high tariff was the first rung of the ladder by which the Revisionists were eventually able to climb back into the SPD, from which Bebel had seriously considered expelling them. Thus in 1901 Bebel invited Eduard Bernstein to join the common front against the protective tariff bill (Bebel to Bernstein, May 24, 1901, Nachlass Bebel [hereafter cited as NB]A, Folio 6/16, in archives of the International Institute of Social History, Amsterdam [hereafter cited as IISH]. In 1901 at the Lübeck Convention of the SPD the delegates were in complete accord in supporting Bebel in his opposition to the government's protectionist policy. See Bebel, "Nachklänge zum Lübecker Parteitag," *Neue Zeit*, 20, No. 1 (1902): 100-101. Bebel was, however, only one of two principal SPD spokesmen in the Reichstag against the tariff. Albert Südekum was the other (Matthias and Pikart, Pt. 1, No. 77, November 27, 1901, p. 72 and No. 78, December 5, 1901, p. 73).

[54]See Bebel's remarks at the Munich Convention of the SPD: *Protokoll über die Verhandlungen des Parteitages der Sozialdemokratischen Partei Deutschlands abgehalten zu München vom 14. bis 20. September 1902* (Berlin, 1902), pp. 224-26.

[55]Bebel in *VR*, 11th leg. per., 2nd sess., I (December 7, 1905), 147-48, 150; and *ibid.*, December 14, 1905, p. 311; and in *Protokoll über die Verhandlungen des Parteitages der Sozialdemokratischen Partei Deutschlands abgehalten zu Jena vom 17. bis 23. September 1905* (Berlin, 1906), p. 151; and in *VR*, 12th leg. per., 1st sess., CCXXX (March 23, 1908), 4235-36.

[56]See Bebel's remarks in *ibid.*, January 29, 1908, pp. 2728-29. Bebel knew that the Conservative parties were becoming suspicious of a fleet which by 1908 was absorbing 41.9% of total expenditures on the army and yet had little or no prospect of ever winning that decisive single battle against the British Home Fleet of which Tirpitz was dreaming. Cf Berghahn, "Der Tirpitz Plan und die Krisis des preussisch-deutschen Herrschaftssystem," in *Marinepolitik*, p. 106.

[57]See Bebel in *VR*, 12th leg. per., 1st sess., CCXXVII (February 26, 1907), 59; and *ibid.*, CCXXIX (November 29, 1907), 1899. Bebel knew by 1908 that the chancellor, Finance Ministers von Stengel and von Sydow, and even Tirpitz had all come to realize that the huge expenditures necessitated by naval increases provided for in the supplementary bills

of 1906 and 1908 could not be defrayed except with some revenue from direct taxes, which would constitute a sop to the parliamentary opposition. See Peter Christian Witt, "Reichsfinanzen und Rüstungspolitik," in *Marinepolitik*, pp. 160-61. See further, Germany, Auswärtiges Amt, Abteilung A, UM 125, Deutschland No. 103, "Akten betreffend die finanzielle und wirtschaftliche Reform," vols. XI-XIII: Memorandum of von Tirpitz, May 4, 1905, M 172. St. M. Ganz geheim; memorandum of von Bülow, May 11, 1905; minutes of the meeting of the imperial ministerial council of June 9-10, 1905, in which Finance Minister von Stengel, alluding to expected budgetary deficits and the need to strengthen the fleet, said that it would be absolutely necessary to levy direct taxes, specifically inheritance and property taxes, "upon the more affluent circles" so as "to spare insofar as possible the broad masses" (pp. 2-4); memorandum of Finance Minister von Sydow of June 3, 1908; and the minutes of the meeting of the imperial ministerial council of June 28, 1908, which declared unanimously for tax reform, including extension of the inheritance tax (*Erbschaftssteuer*) and in which Sydow claimed with some exaggeration that he had even persuaded the Conservatives to see that the new inheritance tax would benefit imperial finances and that only the Center would resist it, but ineffectually (pp. 4-5).

[58]Theodor Eschenburg, *Das Kaiserreich am Scheideweg. Bassermann und der Block* (Berlin, 1929), pp. 68 and 85; and Witt, pp. 265-70. For the Social Democratic report on the fight to destroy the Bülow Bloc see *Protokoll über die Verhandlungen des Parteitages der Sozialdemodratischen Partei Deutschlands abgehalten zu Nürnberg vom 1. bis 19. September 1908* (Berlin, 1908), pp. 128-29.

[59]Berghahn, *Der Tirpitz Plan*, p. 589. In spite of Bebel's strenuous efforts to block the *Novelle* of 1908 (*VR*, 12th leg. per., 1st sess., CCXXX [January 29, 1908], 2729; and *ibid.*, March 23, 1908, p. 4236), it passed the Reichstag by a large majority.

[60]Bebel, of course, was convinced of this. In corroboration of his belief he pointed to the highly emotional atmosphere that reportedly prevailed in England as regards German naval armaments (Bebel to Hermann Molkenbuhr, August 20, 1908, Nachlass Hermann Molkenbuhr, Archiv der Sozialdemokratie, Bonn, Standort Tr-i-1, K.1, Folio 9; idem, August 26, 1908, ibid., F. 10; and idem, September 28, 1908, ibid., F. 11). British hysteria was, in fact, mirrored in a report in the London *Times*, May 21, 1908, p. 9.

[61]These reports by the British consul, Sir Henry Angst, to the Foreign Office are the subject of an article by R. J. Crampton ("August Bebel and the British Foreign Office," *History*, 58 [1973]: 218-32) and a book by Helmut Bley (*Bebel und die Strategie der Kriegsverhütung 1904-1913. Eine Studie über Bebels Geheimkontakte mit der britischen Regierung und Edition der Dokumente* [Göttingen, 1975]).

[62]Angst to Maxse, October 24, 1913, in Crampton, *loc. cit.*, pp. 219-20; Angst to Tyrrell, May 1, 1911, *ibid.*, pp. 220-21; and in Bley, Doc. 8, p. 156. Bebel's remarks, too, in *VR*, 12th leg. per., 2nd sess.,

CCLXVIII (November 11, 1911), 7805; and Bebel to Friedrich Brühne, November 21, 1911, NB, A, F. 10/5, IISH.

[63]Groh, *Negative Integration*, pp. 293, 339 and 345. The imperial finance minister, Adolf Wermuth, had been obliged to resign because he would not agree to accept responsibility for the large naval expenditures over the coming five years contemplated in the *Novelle* of 1912 (Wermuth, *Ein Beamtenleben. Erinnerungen* [Berlin, 1922], pp. 311-13. The SPD voted along with the Reichstag minority against the naval supplementary bill (Groh, p. 330).

[64]*Ibid.*, pp. 330 and 333; and Georg Alexander von *Müller, Aufzeichnungen des Chefs des Marinekabinetts, Admiral von Müller über die Ära Wilhelms II*, ed., by W. Görlitz (Göttingen, 1966) memoranda of January 1 and 12, 1913, p. 105.

[65]Cited in *Sozialdemokratie und nationale Verteidigung*, ed. by the Central Committee of the SPD (Berlin, 1916), p. 16.

EFFECTS OF PLANT HORMONES ON THE GROWTH AND PIGMENTATION OF *EPICOCCUM NIGRUM* AND *HELMINTHOSPORIUM TETRAMERA*

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INTRODUCTION

Although some of the earliest plant hormone research was done with fungi, most research involving auxins, gibberellins, and cytokinins has been with higher plants. Both auxins and gibberellins have been reported as fungal products (Leopold 1960; Phinney and West 1961; Gogala 1972; Pegg 1973a,b) and cytokinins have been reported as products of yeast (Armstrong *et al.* 1969; Giannattasio *et al.*, 1969). There have been few reports on the effects of phytohormones on fungi and some have presented conflicting results (Yangishima and Masuda 1965; Letham 1967; De Bievre 1968; Yangishima and Shimoda 1968; Leelavathy 1969; Jakubowska *et al.*, 1970; Vetter and Maroti 1971; Maxwell and Spoerl 1972; Singh and Gupta, 1972). This report summarizes the results of a study on the effects of certain plant hormones on the growth and pigment production of the two imperfect fungi, *Epicoccum nigrum* Link and *Helminthosporium tetramera*.

METHODS AND MATERIALS

Epicoccum nigrum and *Helminthosporium tetramera* were grown in stationary cultures on Czapek-Dox liquid medium at pH 7.2. Experimental cultures contained 4.5×10^{-4}M indole-3-acetic acid (IAA), 2.3×10^{-4}M gibberellic acid (GA), and 3.7×10^{-4}M kinetin. Control cultures contained only Czapek-Dox broth.

Helminthosporium: H. tetramera was grown for 3 weeks in the dark at 25 C on medium containing the appropriate hormone. The cultures were harvested and dried at 40 C for 24 hours.

Epicoccum: E. nigrum was grown at 25 C in stationary liquid cultures on Czapek-Dox medium containing the appropriate hormone. After 26 days growth in a 16 hour photoperiod, each culture was harvested, washed to remove excess media, and dried at 40 C for 36 hours. The orange red pigment was extracted from each culture with 100% methanol for 50 minutes and the mycelium was removed by filtration. The absorption for each extract, diluted 6-fold, was determined and relative concentrations were determined from percent transmission values measured at 422 nm.

RESULTS AND DISCUSSION

Effects of plant hormones on the growth of *E. nigrum* and *H. tetramera:* The general trend in every case, whether the hormone was added alone or in combination, was increased growth. Only IAA used alone caused a significant increase in the growth of both *E. nigrum* and *H. tetramera* (Table 1), but GA used alone also resulted in a significant increase in the growth of *E. nigrum*. Although 2.3×10^{-4}M (79.6 ppm) is considered a relatively high concentration for plant growth hormone studies these results are consistant with those of Leelavathy (1969) who reported that GA caused growth stimulation of *Fusarium nivalo* at 1 to 5 ppm but not at lower concentrations. No inhibition effects were found at GA concentrations of 400 ppm (Leelavathy 1969), but Stowe and Yamaki (1957) reported growth inhibition of several fungi at high GA concentrations and no effect at low concentrations. Singh and Gupta (1972) found no effect of GA on the growth of several fungi, but 0.4% GA influenced the phosphatide and acetone soluble fraction of *Candida albicans*.

Gibberellic acid plus kinetin and GA + IAA resulted in a significant increase in the growth of *H. tetramera* but not *E. nigrum*. This suggests some synergistic effects on the action of GA by these hormones. There are no reports on the effects of plant hormones used in combination of the growth of fungi.

Kinetin used in combination with GA resulted in a significant increase in growth of *H. tetramera* (Table 1) which is difficult to explain since neither kinetin nor GA alone caused a stimulation of growth of this fungus. Cytokinins increased the growth of certain microorganisms and some strains of *Neurospora crassa* (Lee, 1961, Yangishima and Masuda, 1965; Letham, 1967;) while Jakubowska *et al.* (1970) reported that glucose metabolism by *Sacchoromyces cerevisiae* was increased by kinetin at certain concentrations. On the other hand, Vetter and Maroti (1971) reported that kinetin exerted an inhibitory effect on the metabolism of mycelial cultures of *Amanita pantherina*.

Effects of Plant hormones on pigment production by E. nigrum: The effects of IAA, GA, and kinetin used alone and in combination on pigment production by *E. nigrum* was determined. Only IAA used alone and in combination caused a significant decrease in pigment production by *E. nigrum* (Table 2). The influence of IAA + K and IAA + GA was significant, but was not as great as with IAA alone. Grebanovsky-Sassu and Foppen (1967) showed that the orange-red pigment of *E. nigrum* was composed of β-carotene (32%), β-carotene (22%), rhodoxanthin (tentative) (40%) and torularhodin (6%). GA and kinetin used in combination with IAA seemed to reduce the stimulatory affects of IAA. There are no reported studies on the effects of plant hormones on pigment production of fungi.

TABLE 1. Effects of plant hormones on the growth of *Epicoccum nigrum* and *Helminthosporium tetramera*.[a]

Plant Hormone[b]	*Epicoccum nigrum* (dry weight, mg)	Increase over control (%)	*Helminthosporium tetramera* (dry weight, mg)	Increase over control (%)
Control	393.9		201.9	
IAA	677.5	71.9 c	295.3	46.3 c
K	493.4	25.2	254.7	26.1
GA	597.8	51.7 c	225.5	11.1
GA + K	528.9	34.2	375.5	82.0 c
GA + IAA	523.1	32.8	329.6	63.2 c
K + IAA	462.9	17.5	257.0	27.2

[a] Statistical analyses were based on an average of 6 samples for each hormone experiment.

[b] IAA-indole-3-acetic acid, GA-gibberellic acid, and K-kinetin.

[c] Significant increase in growth compared to controls was determined by Student T-test.

[d] Values followed by the letter c are significantly different from the control.

TABLE 2. Effects of plant hormones on pigment production by *Epicoccum nigrum*.[a]

Hormone[b]	% Transmission	Decrease in pigment (%)
Control	52.9	--
IAA	33.9	35.8[c]
K	46.2	12.8
GA	47.6	10.1
GA + K	44.6	15.7
GA + IAA	30.9	22.7[c]
K + IAA	36.5	31.0[c]

[a] Statistical analyses were based on an average of 6 samples for each hormone experiment.

[b] See Table 1 for key to abbreviations.

[c] Significant increases over control was determined by Student-T test.

[d] Values followed by the letter c are significantly different from the controls.

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THE *PEROMYSCUS LEUCOPUS* SPECIES GROUP IN ALABAMA

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INTRODUCTION

The *Peromyscus leucopus* species group in Alabama is represented by *Peromyscus leucopus leucopus*, *Peromyscus gossypinus gossypinus*, and *Peromyscus gossypinus megacephalus*. *Peromyscus gossypinus* ranges over the entire state of Alabama, whereas *P. leucopus* is confined to the northern half of the state (Osgood, 1909; Howell, 1921). It is commonly stated that *P. leucopus* prefers upland areas, while *P. gossypinus* frequents swampy, low-lying areas (Howell, 1921).

Difficulties in distinguishing between *P. leucopus* and *P. gossypinus* are prevalent throughout the ranges of these species wherever sympatric populations occur. Such difficulties, coupled with the fact that *P. leucopus* and *P. gossypinus* were found to be interfertile in the laboratory (Dice, 1937; 1940), have led to the conclusion that hybridization occurs under natural conditions in Alabama (Howell, 1921), Virginia (Dice, 1940), and Texas (McCarley, 1954).

The purpose of the present study was to determine if recent collections of *Peromyscus* in Alabama included specimens of *P. leucopus* and to re-evaluate the status of specimens designated as hybrids by Howell (1921).

MATERIALS AND METHODS

A total of 545 specimens from Alabama was available for study, although calculations were based on a smaller number of adults for which both skins and skulls were available. In addition, 30 specimens of *P. leucopus* from outside the known range of *P. gossypinus* were studied to help verify the observed distinctions between *P. leucopus* and *P. gossypinus*.

Standard measurements (total length, length of tail, and length of hind foot) were obtained from skin tags, and body length was derived by subtraction. Skull measurements included the following: greatest length of skull; interorbital constriction; diastemal length; length of maxillary tooth row; greatest length of auditory bulla; width of anterior palatine foramen; and length of anterior palatine foramen. Means were compared by the Student's t-test for significance. Pelage characteristics were not studied.

To obtain data for use as a yardstick in evaluating unidentified specimens, 29 identified specimens (those in the collections of the American Museum of Natural History and National Museum of Natural

History) of *P. leucopus* from Alabama were compared with 41 specimens of *P. gossypinus* from coastal counties of Alabama. Localities for the *P. leucopus* were: Clay Co., Erin (3); Colbert Co., Leighton (1); Dekalb Co., Mentone (3); Hale Co., Greensboro (12); Jackson Co., Woodville (5), Carpenter (2); and Montgomery Co., Barachias (3). The *P. gossypinus* were collected at several localities in northern Mobile (28) and Baldwin (13) Counties.

RESULTS

The specimens of *P. leucopus* from Alabama could be distinguished from those of *P. gossypinus* on the basis of significantly ($P<0.001$) smaller size of all cranial parameters considered (Table 1). The greatest and most consistent differences pertained to length and width of anterior palatine foramen (Figure 1), greatest length of skull, and length of hind foot. The difference in width of anterior palatine foramen was relatively clear cut, with 89 per cent of the specimens of *P. leucopus* measuring 1.5 mm and 100 per cent of the specimens of *P. gossypinus* measured 5.0 mm or greater. In the case of skull length, overlap occurred between 26 and 28 mm. All specimens less than 26 mm were *P. leucopus*, while specimens larger than 28 mm were *P. gossypinus*. Length of hind foot in *P. leucopus* ranged from 19.0 mm (64%) to 20.0 mm (36%), whereas 97.5 per cent of the specimens of *P. gossypinus* measured 21.0 mm or larger. A more subjective method of distinguishing the skulls of *P. leucopus* and *P. gossypinus* was that, in every case, the skulls of the former were lighter and more fragile in appearance.

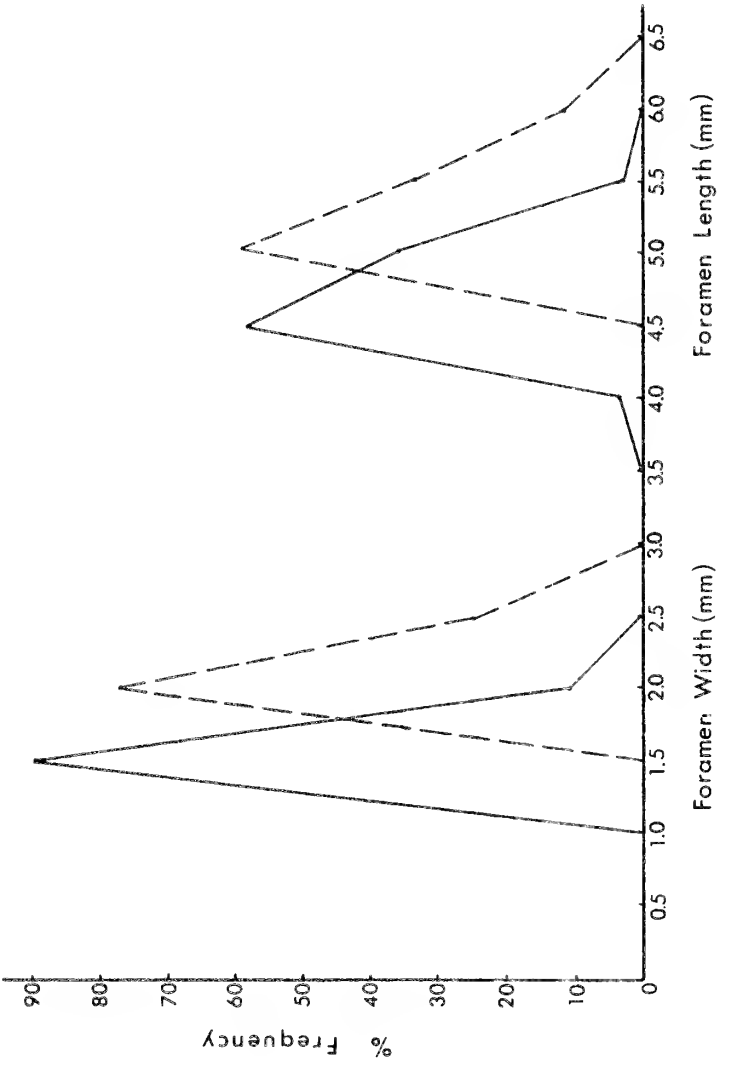
In order to further support the characters distinguishing *P. leucopus* and *P. gossypinus* in Alabama, 30 specimens of *P. leucopus* from areas north of the known range of *P. gossypinus* were examined (Table 1). These specimens were from the following localities: Kentucky: Carroll Co. (4), Meade Co. (2), Fayette Co. (2); Ohio: Athens Co. (3), Clermont Co. (3); and West Virginia: Cabell Co. (1), Greenbrier Co. (6), Hampshire Co. (2), Nicholas Co. (4), Raleigh Co. (2), county unknown (1). These northern *P. leucopus* differed in length of body and tail from the Alabama population, but the lengths of their hind feet and skulls were well within the range for the species. The width and length of the anterior palatine foramen of the two populations of *P. leucopus* were nearly identical.

On the basis of data presented above, the majority of the remainder of the specimens were determined to be *P. gossypinus*. *P. leucopus* was represented only in collections from the following Alabama localities: Lauderdale Co. (2); Lee Co., Auburn (1); and Walker Co. (9). The four individuals from Ardell (Cullman Co.), Dean (Clay Co.), and Tidewater (Tuscaloosa Co.) regarded as hybrids by Howell (1921) were determined to be *P. gossypinus* in the present study. Selected measurements (in millimeters) of these individuals are as follows: length of hind foot - 21, 21, 22, 22; greatest length of skull - 28, 29, 28.5, 27; width of anterior palatine foramen - 2.0, 2.0, 2.0, 2.0; length of anterior palatine foramen - 5.5, 6.0, 6.0, 5.5.

TABLE 1. - Average skin and skull measurements of adult *Peromyscus leucopus* and *Peromyscus gossypinus* (in millimeters ± standard error); sample size is in parentheses.

	Peromyscus gossypinus Alabama	*Peromyscus leucopus* Alabama	*Peromyscus leucopus* Ky., Ohio, W. Va.
Body Length	96.1 ± 1.13 (41)	93.6 ± 2.39 (11)	91.8 ± 1.06 (30)
Tail	71.6 ± .85 (41)	64.2 ± 1.35 (11)	76.7 ± 1.29 (30)
Hind Foot	22.4 ± .45 (41)	19.6 ± .16 (11)	20.6 ± .70 (30)
Skull Length	28.0 ± .19 (35)	25.3 ± .17 (23)	26.1 ± .14 (30)
Interorbital Constriction	4.6 ± .03 (40)	4.3 ± .15 (27)	4.5 ± .03 (30)
Diastema	6.8 ± .08 (42)	6.3 ± .07 (28)	6.3 ± .07 (30)
Maxillary Tooth Row	4.0 ± .03 (42)	3.8 ± .05 (27)	4.0 ± .03 (30)
Auditory Bulla	5.1 ± .05 (41)	4.8 ± .07 (28)	5.2 ± .05 (30)
Anterior Palatine Foramen Width	2.1 ± .03 (41)	1.5 ± .03 (28)	1.8 ± .03 (30)
Anterior Palatine Foramen Length	5.3 ± .02 (41)	4.7 ± .06 (28)	4.7 ± .03 (30)

FIGURE 1. - Anterior palatine foramen widths and lengths of *Peromyscus leucopus* (solid line) and *Peromyscus gossypinus* (broken line).



It is noteworthy that relatively few specimens of *P. leucopus* from Alabama have appeared in collections since the series studied by Howell (1921) was prepared between 1911 and 1916. Specimens from Dekalb County were collected in 1935, whereas individuals were obtained in Lauderdale and Walker counties in 1954-1955. The most recent specimen studied was taken in Lee County in 1967. We have also examined several specimens of *P. leucopus* collected in Lowndes Co., Mississippi, near the Alabama state line, in 1972. During the spring of 1975, which was subsequent to the completion of this study, several individuals identified as *P. leucopus* were collected in Elmore County, Alabama (J. L. Dusi, pers. comm.). These records indicate that the species still occurs at least in parts of its former Alabama range, although probably in low numbers and/or in localized situations.

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Notes

Notes

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ABSTRACTS

Papers presented at the 53rd Annual Meeting
University of South Alabama
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April 8-10, 1976

BIOLOGICAL SCIENCES

EFFECT OF AGING, THYROID LEVEL, ADRENOCORTICOTROPHIC HORMONE AND 3'5' CYCLIC ADENOSINE MONOPHOSPHATE UPON *IN VITRO* ADRENOCORTICAL ACTIVITY

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The present investigation was designed to investigate the *in vitro* responsiveness of the adrenal cortex to adrenocorticotrophic hormone (ACTH) and 3'5' cyclic adenosine monophosphate (c-AMP) in young (60 days of age) and mature (340 days of age) male rats. Additionally, since thyroid hormones are known to influence the rate of adrenocortical activity, young and mature animals were thyroidectomized, subjected to injections of thyroxine (T-4) at rates ranging from 0.5 micrograms per day to 14.0 micrograms per day for 10 weeks. Basal and ACTH stimulated *in vitro* adrenocortical secretion rates of corticosterone were determined in each treatment group.

Analysis of the data revealed that adrenal cortical secretory rates were significantly depressed mature animals. In addition, increases in corticosterone production due to either ACTH or c-AMP stimulation were significantly less in mature animals as compared to their young counterparts.

With respect to thyroidectomy and level of T-4 replacement, although adrenal gland weight was directly proportional to the level of thyroid hormone replacement in both age groups, adrenal secretory rate was not. Increasing T-4 supplementation only moderately increased basal secretory rates and significantly decreased the *in vitro* response to ACTH. In all thyroidectomized, T-4 supplemented groups, basal secretion rate, and ACTH responsiveness was below intact control values.

The data suggest an age-related decline in adrenocortical secretory activity which may in part be related to a decrease in the func-

tional integrity of the adrenocortical ACTH-c-AMP activating system. The data further indicate the age related decline of a thyroid factor other than thyroxine which in turn may influence adrenal cortical responsiveness to its trophic hormone.

^{59}FE ABSORPTION IN THE SMALL INTESTINE OF THE DOMESTIC RABBIT INFECTED WITH *OBELISCOIDES CUNICULI*

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Rabbits were orally inoculated with 800 infective larvae of *Obeliscoides cuniculi*. On either post-inoculum day 22 or post-inoculum day 55, ^{59}ferrous sulfate was given by direct stomach intubation. Liver, stomach, small intestine, and whole blood samples from the hepatic portal vein were assayed for ^{59}Fe content. There was no significant difference in the ^{59}Fe content of the liver, stomach, and small intestine from infected rabbits when compared with ^{59}Fe content of these respective organs from non-infected rabbits. The ^{59}Fe content of whole blood samples from the infected rabbits was significantly higher than the ^{59}Fe content of whole blood samples from the non-infected rabbits. The higher ^{59}Fe content in the whole blood from infected rabbits suggests that iron is elevated in the domestic rabbit which has a patent infection of *O. cuniculi*.

ACROSOMAL PROTEINASE INHIBITORS ASSOCIATED WITH EPIDIDYMAL MURINE SPERMATOZOA

Groesbeck Parham and Gary R. Poirier,
Department of Biology, University of Alabama in Birmingham

A modification of the gelatin substrate procedure of Gaddum and Blandau was used to detect the presence of acrosomal proteolytic enzyme inhibitors. The size of the area lysed by the acrosomal enzymes was used as a measure of activity. A saline extract of epididymal spermatozoa, when mixed with washed spermatozoa, significantly reduced ($P \leq .001$) the size of the lysed area. The extract has antitrypsin activity and is heat labile.

This study was supported by a grant awarded through University College, UAB.

PHAGOCYTOSIS OF *EIMERIA STIEDAI* SPOROZOITES BY RABBIT PERITONEAL MACROPHAGES

Michael V. Dennis*, Phillip H. Klesius**, Carl F. Dixon*

The role of macrophages in the cell-mediated immune (CMI) response to infection by *Eimeria stiedai* was studied by the quantitation of activity. The ability of peritoneal macrophages to phagocytize glutaraldehyde-fixed sporozoites in the presence or absence of serum was also tested. A significant difference in phagocytic activity was found between macrophages obtained from "immune" vs "nonimmune" rabbits. Immune rabbit serum was found to have no significant effect on phagocytosis. Thus, the "immune" macrophage shows a CMI response to infection, independent of antibody.

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INTERACTION OF AGE, THYROID STIMULATING HORMONE AND CYCLIC-AMP UPON *IN VITRO* THYROID ACTIVITY

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The present investigation was designed to study the effects of aging upon *in vitro* thyroid function. Two groups of male rats, aged 60 and 340 days, were used. The animals in each age group were divided into three categories: control, TSH-stimulated and cyclic-AMP stimulated. Animals were sacrificed by decapitation and trunk blood was collected. Thyroid glands were rapidly excised, weighed, roughly minced and incubated in 2 mls Krebs Ringer bicarbonate containing the appropriate stimulating agent for 2 hours under an atmosphere of 95% O_2 - 5% CO_2. Plasma and incubation media were analysed for triiodothyronine (T-3) and thyroxine (T-4) by radioimmunoassay.

Analysis of the incubation media revealed that basal T-3 production was greater in mature than young in glands. TSH stimulation was found to have no effect. Cyclic-AMP on the other hand increased T-3 in both age groups. No age-treatment interaction was apparent considering TSH and CAMP stimulation and T-3 production with age. Thyroid secretion of T-4 was lower in young than in mature glands. TSH increased the release of T-4 in young glands but had no significant effect in the mature glands. Cyclic-AMP elicited increases in T-4 production in both age groups. When viewed in terms of total hormone secreted (T-3 + T-4), basal secretion was lower in younger glands than mature. TSH induced increased release in young but not mature glands and there were similar significant increases with cyclic-AMP treatment in both age groups. Finally, plasma T-3 and T-4 levels were decreased by 30% in the mature animals.

The decreased plasma levels of T-3 and T-4, in view of the greater basal secretion in mature glands, suggests an increased peripheral degradation of thyroid hormone with age. The data also indicates a failure of the mature gland to respond to TSH although it could be stimulated by cyclic-AMP. Since TSH activity is mediated by cyclic-AMP, adenyl cyclase may be implicated as a factor in the decreased response to TSH stimulation with age.

EFFECT OF THYROID STIMULATING HORMONE AND THEOPHYLLINE UPON THYROID ACCUMULATION OF 3'5'-CYCLIC AMP IN AGING RATS

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The purpose of this study was to determine possible alteration in the thyroidal adenyl cyclase-cyclic-AMP activation system during aging. Two groups of male rats, aged 60 and 340 days, were utilized. Animals were sacrificed by decapitation, thyroid glands were removed, weighed, roughly minced and placed into incubation. The glands were incubated for two hours under an atmosphere of 95% O_2 - 5% CO_2 in 2 mls of Krebs Ringer bicarbonate (control) or in a like quantity of incubation medium fortified with either theophylline, TSH, or theophylline plus TSH. The thyroids were extracted for cyclic-AMP and the content thereof was assayed by radioimmunoassay.

Control levels of cyclic-AMP were not significantly different between age groups. Theophylline increased cyclic-AMP accumulation in young glands more than in mature glands, but the difference was not significant. TSH stimulation resulted in a significant increase in cyclic-AMP accumulated in young glands but not in mature glands. TSH plus theophylline greatly enhanced cyclic-AMP accumulation in both age groups, but to a greater extent in the younger glands.

This data indicates that adenyl cyclase activity in response to TSH stimulation decreases with age. Thus the reported age related decline in TSH stimulated thyroid hormone (T-3 and T-4) secretion may in part be explained by a decrease in adenyl cyclase activity in aging animals.

MULTIPLE ANALYSIS FOR MYCOTOXINS IN NATURAL PRODUCTS. I. AFLATOXIN, STERIGMATOCYSTIN, PATULIN, AND PENICILLIC ACID

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A method was developed for simultaneous extraction and qualitative multimycotoxin analysis of natural products. Substrates were extracted with acetonitrile-KCl, defatted with iso-octane, concentrated and

placed on a dry silica gel chromatography column. Mycotoxins were eluted sequentially using series of non-polar to polar solvents. Column fractions were subsequently concentrated and analyzed by thin layer chromatography and compared to known standards. The carcinogenic mycotoxins aflatoxin, sterigmatocystin, penicillic acid, and patulin, described in part I of this report, were successfully extracted, separated and identified by this procedure.

MULTIPLE ANALYSIS FOR MYCOTOXINS IN NATURAL PRODUCTS II. OCHRATOXIN, RUBRATOXIN, ZEARALENONE, AND TRICHOTHECENES

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The multiple mycotoxin analysis described in part I of this two-part report also incorporated procedures for analysis of ochratoxin, rubratoxin, zearalenone, and trichothecenes. Appropriate fractions from the silica gel column previously described were concentrated and further analyzed using thin layer chromatography. The eight mycotoxins included in the multiple analysis were selected because: (1) they may occur naturally in agricultural commodities, (2) they are produced by fungi that are commonly found in these commodities in nature, and (3) the mycotoxin is significantly toxic or is carcinogenic, teratogenic, etc. Also, these mycotoxins are known or believed to be responsible for significant agricultural problems in Alabama. The development of the multi-analysis procedure will make it possible to survey foodstuffs and feeds to determine the extent of the hazard to man and animals presented by mycotoxins in Alabama commodities.

PRODUCTION OF WHEAT X RYE AMPHIPLOIDS

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Seeds of several tetraploid (4x) wheats and diploid (2x) ryes were acquired from USDA and world-wide sources. Original triticales are being produced by using embryo culture and different colchicine techniques. Crosses attempted between different species of tetraploid wheat and diploid rye indicated that *Triticum durum* had its highest crossability value (7.73%) with *Secale cereale*, which also was a good combining male parent with *T. dicoccoides* and *T. polonicum*. Tetraploid wheats varied widely in crossability with Secale species. Hexaploid triticale crossed readily with hexaploid (6x) wheat and Octaploid (8x) triticale. Attempts to produce a tetraploid triticale resulted in zero percent crossability.

LAMIACEAE OF NORTHEAST ALABAMA

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The Lamiaceae family is well represented by flowering herbs in a variety of habitats in Northeast Alabama. The first mints to bloom in the spring are *Lamium amplexicaule* and *Lamium purpureum*. Other spring mints include *Ajuga, Blephilia, Glechoma, Monarda, Prunella, Salvia,* and *Scutellaria. Dracocephalum, Leonuris, Mentha, Nepeta, Pycnanthemum,* and *Teucrium* are representatives of summer-flowering mints. Mints which flower during the fall include *Collinsonia, Satureja,* and *Trichostema.* Various species of mints are generally in flower from February until October.

ASPECTS OF THE BIOLOGY OF AN UNUSUAL COLONIAL CILIATE OF THE GENUS *OPHRYDIUM* (OPHRYDIIDAE: PROTOZOA)

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In December 1975, numerous large, green gelatinous colonies of a ciliated protozoan were found in a semi-permanent pond 3 miles east of Tuskegee, Macon County, Alabama. Colonies taken into the laboratory were examined and found to be members of the peritrichous genus *Ophrydium* (Ophrydiidae). Highly contractile, zoochlorellae-containing, cylindrical cells embedded in a gelatinous mass are characteristic of this species and place it in *Ophrydium.* The genus is represented in North America by three species, *O. sessile, O. vernalis,* and *O. ectatum.* The characteristics of this species were found to differ in several respects from previously described species. Means of morphological characteristics are as follows: length (extended) 340 um; width at ciliary wheel (extended) 50 um; and colony size 10 cm (maximum, 23 cm). The size and shape of the cells are similar to *O. extatum,* but the means of attachment within the colony and the size of the colonies in this species is much greater, 46 times the largest size previously described for a North American Species. Colonies brought into the laboratory produced many daughter colonies which were initiated by free swimming individuals. Daughter colonies initially averaged 2-5 mm in diameter. These floated at the surface of the culture and after a period of time began to coalesce with other daughter colonies to form larger colonies. Water quality parameters of the pond did not differ greatly from those of nearby lentic sites. The pH was 5.3, similar to the value given for the Massachusetts site where *O. ectatum* was discovered. Further work may show that this species is new. Alternatively it may be a variant of a previously described form.

LANDSCAPING WITH FLOWERING TREES AND SHRUBS IN NORTHEAST ALABAMA

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Two-by-two Kodachrome slides were shown of the following species of plants: *Abelia grandiflora, Albizzia julibrissin, Callistemon brachyardrus, Camellia japonica, Camellia sasanqua, Cercis canadensis, Chaenomeles lagenaria, Calycanthus floridus, Cornus florida, Forsythia suspensa, Gardenia jasminoides, Hibiscus syriacus, Hydrangea arborescens, Hydrangea macrophylla, Hydrangea quercifolia, Lagerstroemia indica, Liriodendron tulipifera, Magnolia grandiflora, Magnolia soulangeana, Malus floribunda, Prunus* spp., *Pyrus communis, Rhododendron* spp., *Rosa* H. B., *Spirea prunifolia.* Their landscape uses and cultural requirements were discussed.

EFFECTS OF TEMPERATURE ON THE POPULATION OF A SPECIFIC BACTERIUM IN THE INTESTINAL TRACT OF A POIKILOTHERM, *Sceloporus undulatus*

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Microscopic examination of the fecal material from freshly captured *Sceloporus undulatus* revealed low levels of an unusually large bacillus containing two ellipsoid, terminal spores. When the lizards were maintained in the laboratory at 36°C, a dramatic increase in the numbers of this microorganism occurred within ten days in 75% of the animals. The remaining 25% never developed high levels of the large bacillus, even after two months of incubation at 36°C. None of the animals in the control group, maintained at 25°C, developed increased levels of the large bacillus.

Supported by a grant from the Graduate School, University of Alabama in Birmingham.

MICROBIAL FLORA OF THE INTESTINAL TRACT OF THE LIZARD, *Sceloporus undulatus*

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Recent literature is rich in information on the intestinal microbiota of certain homeothermic species while virtually void of similar information for poikilothermic animals. For this reason initial investigations of the intestinal biota of the lizard *Sceloporus undulatus* have been undertaken. Information on an animal's intest-

inal biota is meaningful when considered in the context of certain of the animal's ecological parameters such as range, habitats, and feeding patterns. An examination of the lizard's gastrointestinal tract as well as microscopic observations of the lumen's bacterial content are presented. Several aerobic and facultative anaerobic bacteria have been isolated and characterized. The data presented show that the lizard's flora differs considerably from other animal systems previously examined. The complexity of microbe-microbe and microbe-metazoa interactions is a major prohibitive factor in discerning the singular effects on the host of any one of the bacterial species. Through careful examination of many different types of animal intestinal systems it is hoped that insight may be gained into the *in vivo* function of individual microbic species.

Supported by a grant from the Graduate School, University of Alabama in Birmingham.

A PRELIMINARY SURVEY OF ALABAMA TARDIGRADES

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Various sites in Alabama and North Florida were sampled for tardigrades over a period of about 18 months. Mosses, lichens, and shelf fungi composed most of the samples. These were placed in petri dishes filled with water and later scanned for tardigrades, which were removed and mounted on permament slides for taxonomic purposes.

The fauna represented in this study is similar to that found in other parts of North America. Three families, seven genera, and twenty-four species were identified. Two species, *Echiniscus viridissimus* and *Macrobiotus pustulatus* are new to the Western hemisphere. *Itaquas con bartosi* is new to North America and *Hypsibius rugosus* is new to the United States.

Two species of tardigrades were collected which possessed the unusual feature of lacking claws on the hind pair of legs. The specimens of one species appear to belong to the genus *Haplomacrobiotus*, the other to the genus *Macrobiotus*. These may represent undescribed taxa or may be aberrant specimens of known species.

Species found were as follows: *Echiniscus viridissimus, Pseudechiniscus suillus, Milnesium tardigradur, Macrobiotus macronyx, M. islandicus, M. echinogenitus, M. hufelandi, M. intermedius, M. pustulatus, M. areolatus, M. richtersi, M. harmsworthi, Hypsibius scoticus, H. pinquis, H. oculatus, H. schaudinni, H. augusti, H. angustatus, H. rugosus, H. oberhauseri, H. convergens, H. pallidus, Itaquascon bartosi,* and *I. umbellinae.*

THE EFFECTS OF ADRENAL AUTO-TRANSPLANTATION ON GRANULOSA NEOPLASMS IN THE RAT

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This study was designed to illustrate the effects of adrenal auto-transplantation on the body and on neoplasia of the granulosa-theca cells of the ovary in albino SAF/SD *Rattus norvegicus*. Of 175 experimental female rats, 50 were used as controls. The adrenal auto-transplant group numbered 50. After transplantation to the fascia surrounding the femoral vessels in the groin, the cortex of the adrenal gland hyper-functioned. The chromaffin cells of the adrenal medulla were resorbed. The remaining 75 rats underwent a spleen-to-ovary transfer in which the spleen was removed and 20% of it was relocated within the bursa of the ovary. After several weeks (4-10 weeks) carcinoma of the granulosa-theca cells developed. Thirty rats, after development of this carcinoma, then underwent an adrenal auto-transplantation. Within five weeks of the adrenal auto-transplantation a definite stunting of the growth of this carcinoma had occurred and within twelve weeks the carcinoma was localized at the site of the ovary. Blood urea nitrogen and 17-ketosteroids were monitored for twelve weeks in each of the aforementioned groups of rats to show the change in adrenal cortical function. Results of these tests suggest that adrenal cortical hyper-function after auto-transplantation limits or controls with growth of the ovarian neoplasm.

BIOELIMINATION OF ^{59}FE VERSUS EGG PRODUCTION IN *DROSOPHILA MELANOGASTER* WHEN LARVAE ARE REARED IN A VARIETY OF ENVIRONMENTAL SITUATIONS

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Larvae of *Drosophila melanogaster* (Meigen) were subjected to variations of three different environmental factors: temperature, photoperiod, and larval density, to determine their effects on a relationship between egg production and ^{59}Fe elimination in the laboratory. Data from these experiments were used to construct regression lines which were then tested statistically to determine if there were significant differences within treatments. It was found that larval density and photoperiod did not effect this relationship. However, temperature variations produce significant differences in the relationship between egg production and bio-elimination and these results indicate that in attempting to use percent elimination of ^{59}Fe in predicting egg number, temperature is a factor that must be regulated.

PREDICTION OF EGG PRODUCTION IN *DROSOPHILA MELANOGASTER* (MEIGEN) BASED ON BIOELIMINATION OF ^{59}FE

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Variations of six environmental factors, photoperiod, humidity, presence of a toxicant, confinement space, temperature, and food availability, were examined to determine their effects on a relationship between egg production and ^{59}Fe elimination in *Drosophila melanogaster* in the laboratory. Cumulative data from these experiments were used to construct a single predictive regression to serve as a means of indirectly estimating egg production from ^{59}Fe elimination data obtained from flies released and recaptured from an enclosure approximating natural conditions.

In addition, a group of 50 labeled female *Drosophila* was released into a screened insectary to test the feasibility of recapturing flies exposed to simulated natural conditions. Nuclide elimination data obtained from these flied were used to make predictions of egg production using our predictive regression.

ENVIRONMENTAL CONTROL OF THE REPRODUCTIVE CYCLE OF THE MALE FENCE LIZARD, *Sceloporus undulatus*

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A limited amount of information is available concerning environmental control of annual testicular cycles in reptiles. Very little of this work deals with temperate-zone forms. The testes of the lizard *Sceloporus undulatus*, a common species of the southeastern United States, are fully regressed in both size and spermatogenic activity by mid-summer. During fall the testes enlarge, and the early stages of spermatogenesis commence. Upon the lizard's emergence from hibernation in spring, the final stages of spermatogenesis are completed in the enlarged testes. The role of photoperiod and temperature in controlling these processes was investigated by placing lizards at various seasons of the year under combinations of short daylength (8 hr light), long daylength (16 hr light), cool temperature (23°C) and warm temperature (32°C). The results indicate that increasing temperature during spring and early summer is the primary factor controlling testicular regression, with photoperiod playing no significant role. Testicular enlargement during late summer-early fall is enhanced by cool temperatures. Warm conditions during this period retard testicular growth, but greatly accelerate spermatogenesis. During this same period, testes in lizards exposed to cool

temperatures. Warm conditions during this period retard testicular growth, but greatly accelerate spermatogenesis. During this same period, testes in lizards exposed to cool temperatures were significantly larger under short daylengths than under long daylengths. The results indicate that the regenerative phase of the testicular cycle in fall is controlled primarily by temperature, with decreasing photoperiod playing a modifying role.

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ISOLATION AND CHARACTERIZATION OF FLOC FORMING BACTERIA FROM MUNICIPAL AND INDUSTRIAL WASTE TREATMENT PROCESSES

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Bacterial isolates were obtained from both municipal and industrial waste treatment processes by plating serial dilutions of activated sludge on sodium benzoate, phenol and nutrient agar and testing for ability to form floc in arginine medium with a carbon:nitrogen ratio of 10:1.

Biochemical tests and substrate versatility experiments revealed that several different kinds of bacteria from municipal and industrial wastes are capable of floc formation. Furthermore, these two environments yielded clearly distinguishable microbial populations, and within each population there were differences in the ability of individual strains to produce floc. None of the isolates studied could be identified as *Zooglea ramigera*, the only previously investigated floc forming bacterium.

Supported by a grant from the Graduate School, University of Alabama in Birmingham.

NOISE STRESS AND ADRENOCORTICAL FUNCTION IN FERAL *SIGMODON HISPIDUS*

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Feral *Sigmodon hispidus* were utilized in an investigation designed to detect possible noise-related changes in both basal and ACTH stimulated *in vitro* corticosterone secretion rates as well as adrenal levels of 3'5' cyclic adenosine monophosphate (c-AMP). Paired adrenals from control animals and from animals exposed to recorded intermittent high intensity noise were initially incubated in the presence or absence of ACTH and

then subjected to a second incubation with ACTH. Incubation media were assayed fluorometrically for corticosterone and adrenal content of c-AMP was determined by radioimmuno-assay.

During the first incubation, glands from control male and female animals exhibited lower basal corticosterone secretion rates than did their noise exposed counterparts. However ACTH elicited a significantly greater response in control animals in terms of coricosterone secretion and glandular accumulation of c-AMP as compared to the noise exposed group. Analysis of corticosterone secretion during the second incubation revealed no difference in adrenal responsiveness to ACTH in either the control or noise exposed group.

The data suggest that noise exposure may interact with the organism so as to increase adrenal levels of a factor or factors which in turn antagonize the expression of ACTH upon the adrenal cortex.

ENCYSTMENT AND EXCYSTMENT OF THE POLYP OF THE FRESHWATER JELLYFISH, *CRASPEDACUSTA SOWERBYI* (CNIDARIA: HYDROZOA)

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Cultures of *Craspedacusta sowerbyi* polyps were allowed to stand without changes of water for periods of several months. Rice grains were added to the cultures to enhance bacterial growth. Degeneration of the oral ends of the polyps accompanied by the elaboration of a tough covering at the base of each was observed. In a period ranging from two to six days after the original degeneration the polyps withdrew completely into the basal covering and a cyst was formed. The old water was removed and fresh culture medium or distilled water was added. Within a period of forty-eight hours the majority of the polyps had excysted, reformed a functional capitulum and begun feeding. The age of the cyst did not appear to affect the rate of excystment or the percentage of cysts undergoing excystment.

SOME STRUCTURAL AND FUNCTIONAL FEATURES OF PROMETAPHASE IN DIVIDING CELLS

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Dividing cells from plant and animal sources were selected during times of prometaphase and prepared for observation in the electron microscope (EM). In addition to routine or control preparations, some cells were selected for a prior exposure to $4^{o}C$ prior to routine EM preparation. Some cells were collected at various times during the drop from ambient down to $4^{o}C$. Microtubules (MTs) associated with kinetochores

were found to be present only after the initial rupture of the nuclear envelope (after the prometaphase event). Following exposure to 4°C, MTs associated with kinetochores were no longer present; however, upon raising the temperature back to ambient, MTs associated with chromosomes (as opposed to pole-to-pole) were first observed at kinetochore surfaces. Our observations point to the kinetochores as being the source of chromosomal MTs during mitosis and meiosis and supports the developing concept that pole-to-pole (or continuous) MTs and chromosomal (or kinetochore) MTs have separate origins during the preparations for metaphase.

SPECIES OF DRECHSLERA AND CURVULARIA FOUND ON CORN IN ALABAMA

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It has long been known that a number of dematiaceous hyphomycetes cause leaf spots on corn. During the summer of 1975 collections made at the Piedmont Substation, Camp Hill, Tallapoosa County, Alabama, yielded eight such fungi including one new species. *Drechslera maydis* (Drechsler) Drechsler, *D. turcica* Luttrell, and *D. rostrata* (Drechsler) Richardson & Fraser were the most important economically, causing southern leaf blight, northern leaf blight, and "helminthosporium" leaf disease respectively. Other species found associated with corn leaf spots included *D. sativus* (Ito & Kuribayshi) Drechsler ex Dastur, *Curvularia lunata* (Wakker) Boedijn, *C. geniculata* (Tracey & Earle) Boedijn, *C. eragrostidis* (P. Henn.) J. A. Meyer, and *C. gudauskasii* Morgan-Jones & Karr. *C. gudauskasii* was the new species found.

NOTEWORTHY WEEDY PLANTS OF MOBILE COUNTY, ALABAMA

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A great diversity of weedy plants occur in the Mobile area partly because of the relatively mild climate in this region and because of the variety of habitats available there. Recent disturbances of natural communities by man have greatly increased the number of sites suitable for weed invasion.

Many of the present-day weeds in the Mobile area occurred already there at the turn of the century and were listed by Charles Mohr in his "Plant Life of Alabama" (1901). On the other hand many other local weeds listed by Mohr, particularly those introduced with ship ballasts, have apparently not persisted till the present. Some of our "Modern" weed were not listed by Mohr and were not even mentioned more recently by Small in his "Manual of the Southeastern Flora" (1933).

Some of those weeds recently established in the Mobile area are native to tropical America, for example *Acalypha setosa* (Euphorbiaceae), *Brachiaria platyphylla* (Poaceae), *Calyptocarpus vialis* (Asteraceae), *Hyptis mutabilis* (Lamiaceae), and *Phyllanthus urinarius* (Euphorbiaceae). Others are Asiatic, for example *Aneilema nudiflorum* (Commelinaceae), *Crepis japonica* (Asteraceae), *Fatoua villosa* (Moraceae), *Mazus japonicus* (Lamiceae), *Wahlenbergia marginata* (Campanulaceae). A few recent weeds such as *Sherardia arvensis* (Rubiaceae) are European plants already established in the more temperate parts of North America while other like *Stachys floricana* (Lamiaceae) are native in other parts of the southeast.

FUNGAL LIPIDS: RUST AECIOSPORES

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Hydrocarbons, fatty acids, and sterols of *Cronartium fusiforme* aeciospores were analyzed by gas chromatographic and mass spectrometric techniques. Low levels of aliphatic hydrocarbons (C_{20} - C_{34}) were detected in the spore extracts but the distribution pattern was not typical of rust spores in general. The major sterol component (ca. 98%) of the spores was stigmasta-7,24(28)-dienol. The fatty acid distribution was typical of most fungi, ranging from C_{12} to C_{20} in chain-length. The predominant fatty acid was 9,10-epoxyoctadecanoic acid (49.4%) followed by C_{16} (12.3%) and $C_{18:3}$(9.2%). The total lipid represented 3.7% of the spore dry weight which is low compared to aeciospores of other *Cronartium* species.

BIOLOGY OF THE RHIZOSPHERE

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The rhizosphere is the narrow zone of soil around plant roots which contains root exudates, sloughed cells, and a variety of microorganisms. Exudation is usually more pronounced just behind the root cap in the meristematic region of rapid cell division. Principal components of root exudates are sugars, amino acids, organic acids, growth factors, and enzymes. Microorganisms responding to these nutrient sources are bacteria, actinomycetes, fungi, nematodes, microinsects (mostly Collembola), and mites. Fungi and nematodes in the rhizosphere include both saprophytic and parasitic forms. Effective root parasites must become established in the rhizosphere in competition with other microorganisms, which act as biological deterrents to invasion.

Results of experiments revealed both introduced and natural phenomena that may alter the quantitative and qualitative nature of the rhizosphere microflora. Herbicides used at excessive rates may injure plants and predispose them to attack by pathogens. Trifluralin (Treflan) inhibited root development of cotton seedlings and favored germination of chlamydospores of *Fusarium oxysporum* f. sp. *vasinfectum* (cotton wilt pathogen) in the rhizosphere. Soil fertility influenced the R/S ratio (rhizosphere/non-rhizosphere) of microbial population. Finally, it was found that microarthropod insects, especially the Collembola, were abundant in cotton seedling rhizosphere to which they migrate during dry periods. They were shown to transport saprophytic and pathogenic fungi and bacteria on and in their bodies and initiate the microfloral colonization of the rhizosphere and root surface.

SOME MORPHOLOGICAL AND ANATOMICAL FEATURES OF ROOT DEVELOPMENT IN BAHIA GRASS *(PASPALUM NOTATUM* VAR. *SAURAE)*

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The root system of bahia grass is under study at Auburn University because of its ability to grow through compacted soil layers. Studies at the Auburn University rhizotron indicate that cotton roots will not penetrate a compacted soil layer and become matted above it, whereas bahia grass roots readily grow through a soil of high bulk density. This study was initiated to determine whether morphological and anatomical features of bahia grass roots may account for their ability to penetrate compacted soil. Observations indicate that after seminal roots are formed, all additional roots that form are stem-borne adventitious roots which appear as tillering is initiated. These roots become increasingly larger, some approaching 2mm in diameter. Smaller-diameter roots are initially monarch, but later, with increasing diameter become polyarch. The cortex in the root hair zone of smaller diameter roots is homogeneous and simple in structure and is bounded by a thin-walled epidermal layer. The larger-diameter roots exhibit a polyarch pattern of eylem development directly with a conspicuous pith and a wide cortex of radially aligned parenchyma cells. Irregularly distributed intercellular spaces first appear in larger roots approximately 30mm from the root tip. These cortical lacunae increase in number and are regularly spaced in the cortex of the root hair zone, 75-90mm from the root tip. A conspicuous fibrous sheath is present beneath the epidermis in larger roots. The fibrous layers are well-established in the root hair zone and confer considerable rigidity to these roots. The relationship of these structural features of bahia roots to their growth habit in a compacted soil is currently under investigation.

ISOLATION OF A THIOCYANATE DEGRADING BACTERIUM FROM AN INDUSTRIAL WASTE TREATMENT PROCESS

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A thiocyanate degrading bacterium was obtained from a coke waste treatment process using the selective enrichment technique. The isolate, which has been characterized as a Gram negative, motile rod, can use phenol as a carbon source and thiocyanate as a nitrogen source at concentrations of these compounds up to 500 parts per million. However, it is sensitive to cyanide at concentrations greater than 6 parts per million. The organism is also very sensitive to pH and temperature.

Supported by a Grant from the Graduate School, University of Alabama in Birmingham.

THE DEGREE OF GAS VACUOLATION IN *MICROCYSTIS AERUGINOSA* GROWING IN CONTINUOUS CULTURE

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Gas-filled spaces do not commonly occur within the protoplasm of living cells, however certain procaryotic organisms possess unique organelles known as gas vacuoles. Several functions have been attributed to these organelles, including providing cells with buoyancy and shielding cells from high, damaging light intensities. The degree of gas vacuolation in cells grown in batch culture has been reported to respond in different ways to light intensity. It has not been possible, however, to determine whether the influence of light on the degree of vaculation is direct or indirect due to the influence light intensity will have on the rate of growth. *Microcystis aeruginosa*, a blue-green alga which possesses gas vacuoles and is often the dominant species in dense freshwater blooms, has been grown axenically in phosphate-limited continuous culture. The use of continuous culture has made possible the separation of the influence of light intensity and growth rate on the development of gas vacuoles. *M. aeruginosa* grown in continuous culture at a given growth rate but under varying light intensities has a greater degree of vacuolation at the higher light intensities, whereas a variable growth rate at a given light intensity does not have a significant influence. This suggests that the possible function of shielding the cells from damaging light intensities may be an important one in nature.

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SEASONAL INCIDENCE OF TWO VIRAL DISEASES OF CORN

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Incidence of the viral diseases maize chlorotic dwarf (MCD) and maize dwarf mosaic (MDM) was monitored during the summer of 1975 on the Piedmont Substation in Tallapoosa County. Healthy seedlings of corn hybrids Funk's G-4762 (resistant or tolerant to both diseases) and Pioneer 3369A (susceptible to both) were grown in the greenhouse in individual 4-inch pots. Beginning 6 June, and at weekly intervals thereafter, ca. 50 seedlings of each hybrid were transported to the field, exposed for one week, and returned to the greenhouse at Auburn. Incidence of MCD and MDM among seedlings was based on symptomatology at 3-4 weeks after return to the greenhouse. MCD was detected in both hybrids throughout the 6 June-15 August experimental period; MDM was not detected until 13 and 27 June with the Funk's and Pioneer seedlings, respectively. Considering symptoms observed among both hybrids, peak MCD incidence, 31%, occurred during 13-20 June; highest MDM level, 19%, occurred 1-8 August. Generally, incidence of both diseases was higher among Pioneer 3369A seedlings than among Funk's G-4762 seedlings.

EFFECT OF STEROID PRETREATMENT UPON SUBSEQUENT UTEROTROPHIC RESPONSES IN PREPUBERTAL RATS

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Neonatal rats injected with estradiol benzoate or testosterone propionate exhibit reduced uterine responsivity (24 hour wet weight) compared to controls when injected with estradiol-17β on day 21 of life. Control rats exhibit significantly different uterine weights in response to 0.1 μg and 1.0 μg of estradiol administered on day 21 of life, while rats treated neonatally with the above steroids exhibit statistically identical responses to the two different estradiol dosages. The maximal uterine response of the latter is significantly lower than the maximal control response.

Ovarian weights in the experimentally treated rats were smaller than those of controls and the degree of reduction correlated with the degree of reduced uterine responsivity for rats treated neonatally with different dosages of estradiol benzoate or testosterone propionate. This suggests that reduced endogenous estradiol secretion might be implicated. Neonatal ovariectomy confirmed the plausibility of this assumption as uterine weight responses on day 21 in such animals mimiced that seen in rats treated neonatally with steroid hormone esters.

Uterotrophic responses at 21 days of life in rats after reciprocal ovarian transplants in infancy between control rats and rats treated neonatally with testosterone propionate suggest an impairment of hypothalamic control of gonadotropin secretion even prior to puberty which impairs ovarian function and subsequent uterine responsivity. It is suggested that endogenous estrogen secretion during infancy is important in the development of uterine competency to respond to exogenous estrogenic hormones.

AN INFUSION OF WATER HYACINTH INTO WALNUT CREEK IN SOUTHEAST ALABAMA

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Eichhornia crassipes, the water hyacinth is an aquatic pest introduced into the Southeastern United States from South America after the Civil War. In 1956 the water hyacinth was introduced into the Troy Area and was confined to a pond on the northern edge of the Troy State University campus. On February 9, 1975 a nine inch rainfall severely undercut the dam confining the plant. The dam was broken before proper precautions could be taken to prevent the spread of the plant downstream. The ecological effect of the water hyacinth on standing bodies of water is one of a very serious nature and the watershed below the point of introduction contains many natural reservoirs in the form of beaver ponds and oxbow lakes which may be suitable habitat for the development of this pest. The development of a one-thousand acre lake one-half mile below the initial area of infusion is of immediate concern.

The purpose of this paper is to call to the attention of the appropriate authority the need for investigating this problem before it is beyond control.

EFFECTS OF AGING, ADRENOCORTICOTROPHIC HORMONE AND THEOPHYLLINE UPON ADRENAL ACCUMULATION OF 3'5' CYCLIC ADENOSINE MONOPHOSPHATE

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This investigation was designed to determine possible alterations in the adrenal cortical ACTH-adenylate cyclase-cyclic AMP activation system during aging. Two groups of male rats, aged 60 and 340 days, were utilized. Animals were sacrificed by decapitation, adrenal glands were removed, weighed, quartered and placed into incubation. Glands were incubated in 2 mls. Krebs Ringer bicarbonate or in a like quantity of incubation medium fortified with either theophylline, ACTH or theophylline plus ACTH. Adrenal secretory rate of corticosterone was determined fluorometrically and glands were extracted for the radioimmunoassay of c-AMP.

From the basal standpoint, c-AMP levels were essentially equal in young and mature glands. However, basal secretion of corticosterone was substantially less in the mature group. Mature animals accumulated significantly less c-AMP and secreted smaller quantities of corticosterone in response to ACTH stimulation than did their young counterparts. Additionally, young glands accumulated significantly larger amounts of c-AMP and secreted larger quantities of corticosterone in response to theophylline treatment than did mature glands.

The data suggest that observed declines in adrenal secretory activity in the aged animal may be due to either a lack of c-AMP formation in response to ACTH stimulation or an enhanced degradation of c-AMP.

SHORT TERM GONADAL EFFECTS OF VASECTOMY

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Sixty-eight male Carworth C. F. N. P. rats were divided into four groups. In the first group, A, twenty animals were unilaterally vasectomized. The second group, B, contained thirty rats which had been bilaterally vasectomized. Sham bilateral vasectomy was conducted on 10 rats in group C. Eight rats (group D) served as controls.

The rats were killed eight weeks after vasectomy. Testes and thymus were weighed and histological slides were made of the testes. Statistical analyses of the testes and thymus weights showed that there was no difference between the different groups of experimental animals. However, ten percent, or five animals, vasectomized showed histological changes in the seminiferous tubules.

SPONTANEOUS DEVELOPMENT OF MAMMARY TUMORS IN *RATTUS NORVEGICUS*, SAF/SD STRAIN

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The development of spontaneous tumors in *Rattus norvegicus*, in particular those tumors arising in the mammary region, has been an area of intensive research since 1931. Studies conducted by individuals at the Wistar Institute of Anatomy and Biology and the Institute of Cancer Research, Columbia University, have reported low percentages of incidence in cases of spontaneous mammary tumors of a malignant nature (0.158% and 0.01% respectively of the total number of female rats dying during the studies). In our research involving *Rattus norvegicus* of the SAF/SD strain we have noted a much higher rate of incidence for the development of malignant mammary tumors, specifically pseudo-encapsulated fibrosarcomas, than was earlier reported. The present

rate in our colony is approximately 1.3% of total number of female rats. These sarcomas seem to arise in rats of an average age of 175 days from primary adenofibromas in the mammary region. The malignant neoplasms tend to develop in the upper mammary region becoming visible approximately 14 days after unsuccessful attempts at breeding.

SPRING, SUMMER AND FALL FLOWERS OF CHEROKEE COUNTY, ALABAMA

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Wildflowers of Cherokee County, Alabama have been observed, collected and photographed during a ten year period. Significant activity by farming, ranching, forestry, industrial, and real estate operations along with the flooding of thousands of acres behind a dam have resulted in many changes in plant communities in the county. One easily accessible area once populated with *Drosera, Habenaria, Iris, Sarracenia, Sabatia, Spiranthes,* and *Utricularia* has been completely destroyed.

Amsonia, Arenaria, Castilleja, Claytonia, Erigeron, Hepatica, Houstonia, Iris, Lithospermum, Marshallia, Phlox, Potentilla, Ranunculus, Sisyrinchium, Spigelia, Tiarella, Uvularia and *Viola* are genera with one or more spring-flowering species. Summer-flowering herbs are represented by *Linum, Lysimachia, Parthenium, Pycnanthemum, Sabatia* and *Silphium.* Genera with fall wildflowers are *Agalinus, Aster, Gentiana, Helianthus, Liatris, Pluchea, Solidago* and *Vernonia.* Genera such as *Allium, Coreopsis, Delphinium, Lobelia,* and *Oenothera* are represented by species in flower for long periods during the growing season.

THE EFFECT OF FLOWER AND POD ABSCISSION ON THE FERTILITY OF SOYBEANS *(GLYCINE MAX* (L.) MERR.)

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Published reports indicate that a large percentage of the soybean flowers produced by field grown plants in the northern United States abscise before and during pod development. This study was initiated to determine the degree of flower and pod abscission that occurs under field conditions in a variety ("Bragg") of soybeans with a determinate growth habit. The results indicate that flower and pod abscission significantly reduces the yield potential of this variety. More than three-fourths of the potential pods formed per plant during the growing season were shed at various stages of development. The greatest amount of flower abscission occurred during anthesis and postanthesis following pollination prior to the conspicuous protrusion of the ovary from the calyx. In addition to those lost as flowers, more than half of the

remaining pods abscised at later stages of development. Only a small percentage of the total abscissions was attributed to abscised floral buds.

The effect of soil compaction on reproduction in "Bragg" soybeans also was determined. The results indicate that a reduction in formation of flowers, pods, and seeds occurs when plants are grown on a compacted rather than noncompacted soil. The greatest reduction occurred in the number of pods and seeds completing development, thus contributing to a reduced yield.

The results of these studies indicate that abscission of flowers and pods significantly reduces the yield potential of "Bragg" soybeans in Alabama. This effect can be magnified by factors, such as soil compaction, which further diminish the yield potential of the plants. The process of flower and pod abscission and the factors affecting it are under investigation.

THE EFFECTS OF 1, 2, 4, 5-TETRACHLOROBENZENE ON PLANT PARASITIC AND FREE-LIVING NEMATODES

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Attapulgite granules containing 1, 2, 4, 5-tetrachlorobenzene (TCB) in a 10% (w/w) formulation were mixed with 1 kg Norfolk sandy loam at the following rates of active ingredient: 0, 56, 112, 224, 448, 896, 1120, 2242 and 4483 kg/ha. The soil was planted to cotton (M-8) immediately after application of TCB. After 30 days sample was taken from each pot and the live nematodes counted. The roots were examined for galling density (GD = no. galls/g fresh root) and the cotton tops and roots weighed. Numbers of *Pratylenchus* sp. increased significantly at TCB rates of 56 and 112 kg/ha. *Tylenchorhynchus* sp. showed a significant increase in numbers at rates of 56, 112, 224 and 448 kg/ha; conversely, numbers of these nematodes were decreased significantly at rates of 2242 and 4483 kg/ha. Numbers of *Hoplolaimus galeatus* increased significantly at rates of 112, 224 and 448 kg/ha and a significant decrease in numbers of *Helicotylenchus dihystera, Meloidogyne incognita, Tylenchus* sp. and saprophagous nematodes was observed at rates of 896 kg/ha and above. GD values decreased in all TCB-treated pots. Phytotoxicity of TCB toward cotton was observed at all rates with 224 kg/ha and above giving almost 100% kill.

OBSERVATIONS ON THE LIFE HISTORY AND ECOLOGY OF THE SOUTHERN PITCHER PLANT MOSQUITO, *WYEOMYIA HAYNEI* DODGE

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Wyeomyia haynei, the southern pitcher plant mosquito, was described by Dodge in 1947. Its immature stages occur in the fluid held by the leaves of *Sarracenia purpurea*, an insectivorous plant. The mosquito ranges on the Atlantic and Gulf Coastal Plains from South Carolina to Mississippi.

Observations on the life history and behavior of this species have been made based on monthly sampling in a pitcher plant bog in Jackson County, Mississippi. The adults appear in March, mate, and the females deposit eggs within young leaves of *Sarracenia purpurea*. The larvae and pupae develop in the fluid within the leaves and feed on protozoans.

Laboratory studies indicate that the eggs hatch approximately 3 days after oviposition. The length of the larval stage varies, but typically lasts approximately 14 days. The pupal stage is shorter, lasting from 4-5 days. Several generations occur during a season and adults are continually present during warm portions of the year. The mosquitoes overwinter as first, second, or thired instar larvae.

Wyeomyia smithii, the northern counterpart to this mosquito, has not been reported to feed on blood. *Wyeomyia haynei* has on several occasions, taken blood meals from the observer during field observations.

TOXIGENIC FUNGI FROM COTTON AND COTTONSEED

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Forty-seven cultures of fungi (representing 14 genera and 25 species) isolated from cotton by investigators in Alabama, Georgia, Louisiana, and Mississippi were bioassayed for toxicity to brine shrimp, chicken embryos, and rats. Eleven isolates (7 species) were highly toxic to brine shrimp. Twenty-three isolates (16 species) were highly toxic to chicken embryos and five (3 species) were moderately toxic. Thirty-three isolates (21 species) were bioassayed for toxicity to rats (per os). Extracts of *Fusarium oxysporum*, *Alternaria alternata*, and *A. tenuissima* caused mortality in some rats, while extracts from seven other fungal isolates caused reduced weight gain by at least 10%. Gross pathological changes observed in treated rats included hemorrhages, kidney abnormalities, and shedding of hair.

OBSERVATIONS ON THE FEMALE REPRODUCTIVE CYCLE OF THE LOGGERHEAD MUSK TURTLE, *STERNOTHERUS MINOR MINOR*, IN A NORTH FLORIDA SPRING

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Sternotherus minor minor is an aquatic turtle found in river drainages of the Alabama-Georgia coastal plain and throughout much of Florida. The large, clear springs associated with regions of Karst topography in Florida probably represent optimal habitat due to the presence of dense aquatic bottom vegetation, the constancy of the water temperature, and the abundance of gastropods, which constitute the primary food item of this turtle.

The results presented here were obtained by analysis of data collected during a preliminary study of life history parameters of *S. m. minor* in Millpond Spring, Jackson County, Florida. Monthly examinations of female reproductive tracts revealed a definite reproductive cycle, beginning with a rapid increased in follicular vitellogenesis in late August, resulting in large, yolked ovarian follicles in September. Oviducal eggs were present in samples from September through early June. The occurrence of different size classes of corpora lutea suggests that oviposition begins in late October-November and indicates that most individuals lay 2-3 clutches per year. Clutches of 2-3 eggs are the most common, however clutch size varies from 1-4. The period of greatest reproductive activity, therefore, appears to be from late October-November through the middle of June. Present efforts include attempts to determine specific ecological cues for reproduction.

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MYCOFLORA OF ACTIVATED SEWAGE SLUDGE

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Samples of anaerobically digested sewage sludge were collected from drying beds at the North Auburn sewage treatment plant. Subsamples were diluted with water, and serial dilutions were plated on peptone-dextrose agar containing rose bengal and streptomycin. Fungus colonies were transferred to potato- dextrose and/or Czapek-Dox agar plates for identification. When necessary, cultures were replated and exposed to longwave UV light to induce sporulation. Dilutions of 1:20,000 and 1:200,000 averaged about 25 and 9 colonies per plate,

respectively. Thirty-eight fungi were isolated; the following had not been previously reported as occurring in sewage sludge: *Allescheria crocea*, *Chrysosporium pannorum*, *Dactylaria* sp., *Dactylomyces* sp., *Dichotomyces albus*, *Gliomastix musicola*, *Pseudoeurotium zonatum*, *Talaromyces spiculisporus*, and *Thamnidium elegans*.

ISOLATION AND CHARACTERIZATION OF PHENOL DEGRADING BACTERIA FROM AN INDUSTRIAL WASTE TREATMENT PROCESS

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Thirty isolates of phenol degrading bacteria were obtained from an industrial waste treatment process by direct plating onto agar media containing various concentrations of phenol. Diagnostic procedures indicated that these isolates represent seven closely related species. By comparing colony counts on nutrient agar and 0.025% phenol agar it was estimated that at least 35% of the heterotrophic population is capable of growing on phenol. When the isolated cultures were serially diluted on agar media containing various concentrations of phenol, it was shown that the plating efficiency decreases as the phenol concentration increases. Data are presented on the sensitivity of the phenol degrading bacteria to parameters of the waste treatment process.

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SOME CERCOSPORAE ON LEGUMINOSAE

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A considerable number of fungal taxa, classified in the genus Cercospora, have been recorded on members of the Fabaceae. Cercospora, are the causal organisms of leaf discoloration and necrosis. Dissatisfaction has developed concerning generic concepts and species delimitation. This dissatisfaction has resulted in the need for critical revisions. In its present state, Cercospora is a heterogenous entity and the transposition of some of the taxa within Cercospora to other genera yields a more acceptable classification.

Twenty-three specific epithets have been applied to collections referred to Cercospora on members of Cassia and Psoralea. Of these, thirteen are considered valid. Seven are facultative nomenclatural synonyms. And three are obligate nomenclatural synonyms. Examination of type specimens has prompted the transfer of three of the valid

specific epithets to other genera. Two are more satisfactorily classified in Phaeoisariopsis and one in Cercosporidium.

The names Phaeoisariopsis cassiocarpa, Phaeoisariopsis sphaeroidea, and Cercosporidium ecuadoriana are proposed.

BASAUXIC CONIDIOGENOUS CELLS IN THE FUNGI IMPERFECTI

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Conidiogenous cells that elongate by a basal growing point have long been thought to exist in several genera of the Fungi Imperfecti but the concept of the basauxic phenomenon remained to be unequivocally conidiogenous cells and conidium ontogeny in *Arthrinium phaeospermum* (Corda) M. B. Ellis and *Dictyoarthrinium sacchari* (Stevenson) Damon were studied and illustrated by time-lapse photomicrography and from fixed material. Successive conidia were shown to be produced by lateral extensions of the apical region of the conidiogenous cells in the former species and by production of a number of retrogressive, but not strictly basipetal, conidiogenous loci on a basauxic conidiophore in the latter.

AN ELECTROPHORETIC ANALYSIS OF FIVE HATCHERY STOCKS OF *ICTALURUS PUNCTATUS* (CHANNEL CATFISH)

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One hundred channel catfish were electrophoretically examined to determine the genetic variability and similarity of five hatchery stocks from Auburn University in Auburn, Alabama. Twenty fish were examined from each stock. Fourteen genetic loci were analysed, five of which were polymorphic and nine monomorphic. Results showed that stocks inbred for 15 years were less variable than those more recently removed from natural populations. When crosses were made between the two, the amount of variability in the new strain was intermediate.

There is an indication that as many as 40 loci could be analysed in future studies. Of these, 14 appear to be polymorphic. With this much variability, future electrophoretic studies on this species should provide data of evolutionary, taxonomic, and genetic interest.

LABORATORY STUDIES ON TEA SCALE, *FIORINIA THEAE* GREEN, AN INSECT PEST OF CAMELLIA

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Tea scale, *Fiorinia theae*, is probably the most destructive insect pest of camellias in the Southeast. Whereas control of this scale has been studied extensively, biological information is sadly lacking.

Laboratory studies on tea scale biology were initiated. It was found that the principal natural host, the camellia, is an unsatisfactory substrate for laboratory investigations. Screening tests were conducted to determine if tea scale could develop on other food substrates. It was found that it completes development on the following fruits and tubers: lemon, orange, grapefruit, Irish potato, and squash. Success varied with the host. Best results were obtained with squash, notably butternut squash. A procedure was developed for rearing tea scale on butternut squash and has been used successfully.

This technique will allow detailed observations on growth and development of this scale insect and could also be used to advantage in rearing parasites.

CHEMISTRY

NONCONCERTED THERMODECOMPOSITION OF AZOMETHANE IN THE GAS PHASE

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Azomethane was pyrolyzed in a vacuum flow system at temperatures up to 727°K and pressures calculated to be approximately 300 millitorr. The particle beam exiting the pyrolysis flow system entered a drift space at 10^{-7} torr pressure where it was modulated, underwent electron bombardment and mass analysis with a quadruple mass spectrometer. Mass spectra taken as a function of temperature showed an increase of the mass 15 (CH_3^+) and 43 ($CH_3N_2^+$) peaks relative to the parent 58 ($CH_3N_2CH_3^+$) ion peak. Ionization efficiency curves for CH_3^+, $CH_3N_2^+$ and $CH_3N_2CH_3^+$ showed marked differences at 727°K relative to 298°K. A mechanical velocity selector placed between the beam source and mass spectrometer was utilized to differentiate $CH_3N_2^+$ ions arising from undecomposed $CH_3N_2CH_3$ and the neutral radical CH_3N_2. Comparison of the mass 58 ($CH_3N_2CH_3$) velocity analysis with mass 43 velocity analysis showed the $CH_3N_2^+$ ion originated from two sources, parent $CH_3N_2CH_3$ and CH_3N_2 radicals. Since CH_3N_2 radicals are being produced, nonconcerted decomposition must be occurring.

THE SYNTHESIS OF NINHYDRIN ANALOGS FOR USE IN THE IDENTIFICATION OF AMINO ACIDS

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The purpose of this research is to synthesize a number of *ninhydrin* analogs and homologs for possible use as superior colorimetric reagents in the detection and identification of amino acids.

A critical review of the literature reveals that very little study has been given to the synthesis of *ninhydrin* analogs. In 1957, Meier and Lotter synthesized the following three *ninhydrin homologs: 4-5 benzindan-1,2,3-trione monohydrate; 5,6-benzindan-1,2,3-trione monohydrate;* and *napth (2', 3', 5,6) indan-1,2,3-trione monohydrate.*

It may be conjectured that more extensive work in this area was not attempted because of the lack of a more direct and elegant synthetic route to the *ninhydrin* structure.

The method of synthesis employed in this research was an improved modification of the method of Meier and Lotter. The first *ninhydrin* analog to be synthesized in this research was the *5-chloroindan-1,2,3-trione monohydrate.* The preparative method employed in this synthesis will be discussed.

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PHYSICOCHEMISTRY OF MACROMOLECULAR MOLECULES AND IMMUNOGLOBULINS

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Studies of the physical chemistry of large molecules offer an excellent opportunity to learn physical chemistry techniques and to "keep up" in the ever changing fields of biology, chemistry, and biochemistry. Macromolecular molecules, specifically immunoglobulins and polysaccharides, either intact or digested into fragments, may be carefully studied to establish molecular weights, viscosity, immunochemistry and structure.

Digestion of a Waldenstrom's IgM by trypsin for 16 h at 37°C in pH 8 buffer resulted in the production of a fragment having an $s^{o}_{20.w}$ value of 15S and a molecular weight by sedimentation equilibrium of approximately 650,000 daltons. Smaller quantities of $F(ab)_{2u}$, Fab_{u}

and other fragments were found. Reductive cleavage of the high molecular weight product resulted in the release of 7S subunits and a low molecular weight fragment derived from the Fc portion of the u chain (Fc_u piece). The 7S subunits recovered from tryptic fragment demonstrated only minimal differences from the 7S subunits obtained from the undigested IgM by sedimentation velocity, electrophoretic and immunochemical criteria, and polypeptide chain analysis. The Fc_u piece sedimented in the ultracentrifuge at 2.8S and demonstrated a molecular weight of 35,000 daltons by sedimentation equilibrium at three different concentions. The data indicated the presence of three subunits and three or four Fc_u pieces in the 15S fragment.

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STUDIES ON THE METABOLITES OF *ASPERGILLUS OCHRACEUS* WILHELM

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Recent studies on the isolation and characterization of *Aspergillus ochraceus* metabolites were described. Studies on the biosynthesis of 3-(1,2-epoxypropyl)-5,6-dihydro-5-hydroxy-6-methylpyran-2-one were presented and discussed. Finally, the use of high pressure liquid chromatography (HPLC) for the separation of *A. ochraceus* extracts was presented. Analytical results from HPIC show a number of unidentified metabolites to be present and work on the structure of one of these new metabolites was presented.

APPROACHES TO THE BIOGENETIC TYPE SYNTHESIS OF POLYKETIDE METABOLITES

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The results of a biogenetic type synthesis of the polyketide precursor to anibine was presented. The use of protecting groups in the synthesis of poly β-ketones was discussed. The nitrile functional group as a precursor to ketones and acids in the synthesis of polyketoacids was presented together with recent results on the acylation of acetonitrile using sodium hydride and ethylacetate. The expected product of acylation -acetoacetonitrile- was obtained together with two unexpected products. Structural evidence for one of the unexpected products was discussed and a structure assigned.

GEOLOGY

ELECTRODE CONFIGURATIONS FOR EARTH RESISTIVITY SURVEY OF SUBSURFACE GEOLOGY

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This research was conducted to determine the most practical electrode configuration for shallow subsurface exploration by the electrical resistivity method.

Eight electrode configurations were examined under laboratory conditions to select the most suitable for further trial under field conditions. Those chosen as most suitable for further field tests were the Wenner and a modification of the Wenner configuration.

Data collected in the laboratory and field were analyzed by methods commonly in use and a new method of determining the apparent layer resistivity was devised.

Using these methods of analysis, several conclusions were reached, and are as follows: (1) The data obtained by the Wenner configuration is easily analyzed because of the simple formulas involved in computation. However, data obtained and analyzed by the modified Wenner configuration gives more reliable results, and the modified Wenner configuration is more efficient in terms of time and space requirements. (2) The subsurface depth related to data obtained with a given electrode spread, "depth of penetration", is directly related to the distance between the potential electrodes, using either the Wenner or modified Wenner configurations. (3) Different methods of data analysis, different electrode configurations, variable weather and soil-moisture conditions, and other variable results in different apparent resistivities for given subsurface layers. (4) The apparent resistivity of a given subsurface layer is dependent on the electrical effects of adjacent layers. (5) Experience and geological knowledge of a given area are the most valuable assets in interpretation of electrical resistivity data.

REPTILIAN VERTEBRA FROM THE NANAFALIA FORMATION, COFFEE COUNTY, ALABAMA*

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A reptile not previously described from the lower Eocene, Nanafalia Formation of Alabama, has been collected in northernmost Coffee County.

The specimen, based on identification of a single vertebra, (Troy State University-Specimen #19-1-1) is of the Order Crocodilia.

The single vertebra, collected as float material, was found 0.4 miles south of the Pike-Coffee County line (NE ¼, sec. 4, T7N, R21E) in a road cut along Alabama Highway 167. The geologic sequence exposed in this cut is approximately 25 feet (ft) or 7.6 metres (m) thick. The lower beds, 13½ ft (4.1 m) thick, are a fossiliferous, calcareous, gray shaley clay, while the overlying beds, 11½ ft (3.5 m) thick, are a buff colored, indurated, siliceous claystone. Both of these units represent marine beds of the Nanafalia Formation. This geologic sequence is stratigraphically in the upper 35 ft (10.7 m) of the Nanafalia Formation and is equivalent to beds mapped as the Grampian Hills Member in west Alabama.

The vertebra, although found as float, is believed to have weathered from the upper siliceous claystone. Supportive evidence includes the silicified preservation of the vertebra and also its encasing siliceous matrix which is identical in lithology to the claystone beds.

Crocodiles range from late Triassic to Holocene time. Marine crocodiles, however, were restricted to the Jurassic, Cretaceous and lower Cenozoic Periods. This crocodilian specimen represents an addition to the list of fauna described from the Nanafalia Formation of Alabama.

*Approved for publication by the State Geologist

THE INVESTIGATION OF A MARINE *VS* NONMARINE ENVIRONMENT FOR THE COKER FORMATION (CRETACEOUS)

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One of the more interesting problems concerning Gulf Coastal Plain geology is that of the depositional environment and source area for Tuscaloosa Group sediments. Although these sediments have not been differentiated east of Tuskegee, Alabama, observations in the area between Tuskegee and Auburn indicate that the delineation is possible. In the field, Coker is a sequence of red-and-green mottled mostly clayey, bioturbated sediments that may contain moderately well-sorted sand intervals. By contrast, the Gordo is characterized by buff-to-reddish, poorly sorted, arkosic and micaceous gravelly sand that is typically cross-bedded.

A quiet water, near-shore marine environment with a source area to the northeast is suggested for the probable Coker Formation, as opposed to a fluvial environment for the probable Gordo Formation.

MIDDLE ORDOVICIAN BIOHERMS IN BIRMINGHAM, ALABAMA, AREA

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The Chickamauga Limestone, at Birmingham contains several lithologically and paleontologically distinct units. One of these units 450 feet above the local bottom of the Chickamauga and 75 feet below the local top, contains several biohermal masses that contrast greatly with the surrounding limestones. This unit will be spoken of as the Gate City Limestone. In this paper will be discussed (1) mapping of the bioherms (2) paleontology and relation of the organisms to the bioherms, and (3) description or zonation of several prominent reefs and resemblances to Recent reefs.

The bioherms show several distinct faunal-lithologic zones divided as follows: (1) basal "bryozoa bed" which shows normal bedding and occurs at the base of the bioherms where exposed; (2) a clay-micrite lithology which contains a wealth of fossils and is sub-divided into (2a) bedded clay-micrites that are at the bottom of definite bioherms, (2b) bioturbated clay-micrites, a clay and micrite mixture again rich in fossils, unbedded and occurring mainly on the flanks of the bioherms, and (2c) coral-dominant clay-micrites which occur where the bioherms contact the surrounding bio-sparite (local tops.); and (3) a solid micrite core that varies from lens-shaped, to round, to tabular masses. This core contains many ramose bryozoa and branching receptaculitids which may form a skeleton. In at least one large bioherm this core is not present but instead small micrite patches are attached to very large stromatoporoids. All of the bioherms are surrounded by a cross-bedded, coarse grained, packed biosparite. This sparite was composed mainly of bryozoa fragments, which seemed to make up a large percentage of fossils in the bioherms themselves.

Fossils in the bioherms are noteworthy in that several prominent forms are described only from other formations that may be of correlative use. The trilobite Amphilichas is present at Gate City and is described from the Kimmswick Limestone of Missouri. Paracrinoids that occur in the bioherms are described only from the upper Bromide of Oklahoma and the Ottosee-Benbolt of Tennessee and Virginia. It is noteworthy that the paracrinoids of the Bromide also occur with bioherms. The crinoid fauna in the Gate City bioherms is suggestive of the Ottosee-Benbolt, especially in the presence of *Hybocrinus punctatus*.

THE RED GAP STRUCTURE COMPLEX, BIRMINGHAM, ALABAMA

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A complex of folded structures has been found at Red Gap in eastern Birmingham. The largest structure in the complex is the Red

Gap syncline. This syncline strikes N. 77°W., at an angle of 60° to the Birmingham anticlinorium. At the eastern end of Red Gap, the dip of the axial plane is steeply to the south and closure is about 100 feet; a mile to the west, the axial plane dips at 62° to the north and the closure is about 2,000 feet. The western end of this fold is unknown. Folding is essentially parallel, and the north flank is overturned west of Red Gap.

The Marks Village syncline is a broad, short syncline or elongate basin that trends N. 21° E. Closure on this fold attains a maximum of about 300 feet just to the north of the point where the axis crosses that of the Red Gap syncline, about 3,000 feet west of Red Gap.

A series of arcuate folds lies to the east of the Marks Village syncline. All are characterized by parabolic traces, with foci near the intersection of the Red Gap and Marks Village synclines. In all cases, the axial planes of these folds are twisted through large angles along the trace, and dips are in some places to the concave, and in other places to the convex, side of the curvature of the trace.

The mechanics of formation of the Red Gap structure complex is problematic, but the folding is clearly synchronous with the latter stages of formation of the anticlinorium. It post-dates large-scale normal faulting associated with the early stages of the anticlinorium.

SMALL SCALE STRUCTURE WITHIN THE RED GAP STRUCTURAL COMPLEX, BIRMINGHAM, ALABAMA

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During construction of Interstate Highway 20, excavation of a cut through Red Mountain in eastern Birmingham exposed a number of interesting structures. The south side of the expressway cut and the hill south of the expressway cut is highly folded with the strike of the structures being due North to N 40° E which is north of the general strike of sediments in the area. The north side of the cut is not highly folded but the area further north of the expressway cut is highly folded. The strike of these structures is N 60° E to N 70° E which is east of the general strike.

The structures exposed on the south wall of the expressway cut are interpreted as kink bend structures instead of thrust fault features. It is also suggested that these kink bends interfere with each other, cancel out, and then reappear further down strike thus leading to variations as seen in the Red Gap Structural Complex.

SEDIMENT STATISTICS OF THE HARTSELLE SANDSTONE

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Samples from ten outcrops of the Hartselle Sandstone were collected in North Alabama. The samples were from a triangular area, from Blount County on the east, to Colbert County on the northwest and Jefferson County on the southwest. The composite samples were seived, and the grain size subjected to statistical analysis.

Analysis was done to determine for each sample the mean (weight-average), median, and modal (most common) grain diameter, and the standard deviation of the logarithm of grain diameter. The mean diameter ranged from 0.443 mm in Blount County to 0.130 mm in Colbert and Jefferson counties. The ranges of the median and the mode were 0.121 to 0.379 mm and 0.068 to 0.103 mm, respectively. The standard deviation of the log (base 2) of diameter, which is a measure of sorting, ranged from 0.35 to 0.74.

Regression analysis by matrix calculations was done to determine the direction of transport of the sand. All of the measures of grain size correlated well with geographic coordinates. For all of these, the slope of the regression surface indicated that the sand was transported from a source direction of N. $62.8^{o} \pm 2.5^{o}$ E. There was no significant correlation between the sorting and geographic coordinates. Analysis of the residuals from linear regression did not suggest any variation in the transport direction in North Alabama.

CRITERIA FOR THE DISCOVERY OF ECONOMIC URANIUM DEPOSITS IN THE EASTERN ALABAMA COASTAL PLAIN

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Various criteria for the formation of sandstone-type uranium deposits may be generally related to host rock characteristics, ultimate uranium source, or hydrologic and geochemical factors affecting uranium mobility and deposition. Evaluation of the eastern Alabama Coastal Plain with respect to eleven such criteria (Dennison and Wheeler, 1975) indicates that the Tuscaloosa Group offers the best potential for the discovery of economic deposits. Favorable characteristics are: (1) presence of locally arkosic, fluvial sandstones; (2) local abundance of carbonaceous debris and iron sulfide mineralization; (3) presence of unconformities and shallow regional dips; (4) adequate uranium source.

Past uranium exploration in the eastern Alabama Coastal Plain has been negligible, due primarily to the lack of positive data concerning ultimate uranium sources, and activity and presence of oxidation-reduction fronts. New aeroradiometric data gathered jointly by the

Alabama and United States Geological Surveys, and ground reconnaissance by various groups have identified uranium anomalies in the Piedmont ideally situated to have furnished sediment for the formation of source beds within the adjacent Coastal Plain. Preliminary reconnaissance of Tuscaloosa Group units in close proximity to these uranium anomalies indicates the presence of apparent reduced zones exhibiting abnormally high radiation.

STRIP MINE DRAINAGE IN BLUFF CREEK,* TUSCALOOSA COUNTY, ALABAMA

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Bluff Creek drains an area of 2,100 hectares near the town of Searles, Alabama. Strip mining of four coal beds in the Brookwood Coal Group has disturbed 563 hectares of land within the drainage basin (26.7% of the total basin area).

Multiple samples were collected from 22 stations along Bluff Creek and its tributaries in the period between October, 1974 and May 1975. Field and laboratory analyses were used to measure redox potential, pH, total alkalinity, sulfate, iron, manganese, nickel, chromium, zinc, cadmium, cobalt, and copper.

Sandstone beds with a calcium carbonate cement are exposed along Bluff Creek and act as a natural buffer. Thus the pH of the main stream remains about 6.5 in the upper reaches and alkalinity is high. Both pH and alkalinity decrease near the mouth. The pH of tributaries may be as low as 3, but the water is rapidly neutralized upon entering Bluff Creek.

Iron and manganese behave similarly, do not exceed a concentration of 30 ppm, and generally decrease downstream. Ferrous and manganous ions appear to be the dominant dissolved species of these two elements. Oxidation to ferric or manganic ions is quickly followed by gydrolysis and precipitation of the hydroxides, accompanied with production of hydrogen ions.

Nickel, chromium, zinc, cadmium, cobalt and copper are all present in Bluff Creek at concentrations less than one part per million.

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FIELD RELATIONSHIPS AND STRUCTURAL FRAMEWORK OF THE ALMOND TRONDHJEMITE, RANDOLPH COUNTY, ALABAMA

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The Almond Trondhjemite (plagio-granite) is exposed in the vicinity of Almond, in southwest Randolph County, Alabama. The trondhjemite is enclosed in phyllitic rocks of the Wedowee Group metasediments which occur in the southeast portion of the Northern Alabama Piedmont. The Trondhjemite and enclosing phyllitic rocks have experienced a rather complicated metamorphic and deformational history following the emplacement of the pluton as a sill-like body. This history includes an early deformational phase (D_1-M_1) which (1) recrystallized much of the trondhjemite, imparting to it a pervasive regional foliation and mineral lineation that parallel those within the enclosing Wedowee rocks, but which commonly do not parallel mafic schlieren within the trondhjemite, (2) obscured the original intrusive relationships by isoclinal F_1 folding and associated plastic flow, (3) obliterated possible contact metamorphic effects by eliminating a metamorphic gradient across the contact during the M_1 amphibolite facies metamorphism. A later phase of retrogressive metamorphism and deformation (D_2-M_2) altered the Wedowee pelitic rocks but had little effect on the trondhjemite or on amphibolites interlayered with the Wedowee pelitic rocks. A still later phase of tight flexural-slip folding (F_2) deformed the Wedowee and Almond rocks into large scale folds which are overturned toward the northwest. It is concluded from this study that the Almond represents a poly-deformed granitic intrusive sill-like body whose original igneous nature and geometry have been extensively altered by the major tectonic events affecting the southern Appalachians in the Alabama Piedmont.

A SOLUTION FOR POTTSVILLE CORRELATION IN ALABAMA

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The origin, nature, and distribution of the deltaic sedimentation in the Black Warrior Basin during the Pennsylvanian time engender a complex depositional system. This situation makes physical correlations of Pottsville strata in Alabama difficult. A solution for this problem. may lie in biostratigraphy. Recent discoveries of ammonoids, foraminifera, and ostracods in the Pottsville strata in Alabama will produce a more thorough understanding of the biostratigraphy. The goniatites, *Gastrioceras occidentale* (Miller & Faber, 1892) and *Gastroceras* sp. resemble those specimens from the southern midcontinent and eastern Kentucky. The specimens from Pleasant Grove and Port Birmingham in Jefferson County are thought to be from marine strata in Metzger's stratigraphic interval D (1965, p. 74); this interval would correlate

with the New River Group (Morrowan). Tentative identifications of the foraminifera indicate a *Millerella* - *Eostaffella* type and for the ostracods, *Knightina* and *Kirkbya* at an additional site near Tuscaloosa.

PRELIMINARY GEOCHEMICAL ANALYSIS OF TRACE ELEMENT VARIATIONS WITHIN THE ALMOND TRONDHJEMITE AND BLAKES FERRY PLUTON, RANDOLPH AND CLAY COUNTIES, ALABAMA

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Within a 20 mile radius in southwestern Randolph County 17 trondhjemitic bodies intrude the schists of the Northern Piedmont of Alabama. Trace element concentrations of Co, Ni, Cu, Zn, Rb, Sr, Li, Cd, Cr, and the minor element Mn have been obtained for 15 surface samples and 43 core samples from the Blakes Ferry Pluton and 66 samples from the Almond Trondhjemite.

The objectives of this investigation are to determine if statistically significant geochemical differences exist between these two plutons and if the geochemical data can be used to help explain the origin of the two plutons, their geological history, and genetic relationships.

With computer contour mapping and preliminary statistical data, two preliminary conclusions may be arrived at: (1) There is little evidence that abnormal concentrations of trace elements exist consistently for any one area or that there are constant lateral or vertical variations in the trace elements within the intrusions. However, trace element pairs, such as Co and Mn--because of similar charge and ionic radius--are concentrated together often in highs or lows within specific areas, and (2) The intrusions are very similar geochemically in trace element abundances suggesting a co-genetic origin, or derivation from the same parent magma.

Future study will center upon comparisons of the Almond and Blakes Ferry trace elemental abundances to those from other plutons in the Piedmont. Whole rock major element analyses are being obtained currently from the samples taken from the Blakes Ferry Pluton and Almond Trondhjemite.

FIELD RELATIONS IN THE HILLABEE CHLORITE SCHIST OF THE MILLERVILLE REGION, CLAY COUNTY, ALABAMA

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The Hillabee Chlorite Schist is a predominantly mafic unit which occurs along the border between the high rank and the low rank metamorphic belts of the Alabama Piedmont. It is composed of chloritic rocks, ranging from massive greenstones to chlorite schists, hornblende quartz schists, which may have intruded the chloritic rocks, and interlayered thin quartz sericite phyllites.

In the Millerville area three faults can be identified. To the north the structures in the Hillabee do not conform to those of the Poe Bridge Mountain Group, suggesting a post-metamorphic fault. This fault has been referred to as the Carr Mill Fault.

In the south, where the Hillabee turns back to the southwest, structures do not match those in the Wedowee Group. This suggests a post-metamorphic fault referred to as the Enitachopco-Shady Grove Fault.

Between the contact of the Hillabee rocks and the Talladega Group is a micaceous quartzite. The foliations and lineations of this unit conform to those of the Hillabee, yet the units within the Hillabee terminate at the contact with this quartzite. This is indicative of a pre-metamorphic fault or unconformity.

From these relationships and other field data, it seems unlikely that the rocks of the Hillabee, possibly representing a volcanoclastic sequence, were injected along a pre-existing fault.

Two different lineations are present indicating at least two periods of deformation. A streaking (mineral) lineation occurring in the plane of the foliation is folded by a second lineation--crenulation folds.

SEDIMENTATION IN HARRIS LAKE, TUSCALOOSA COUNTY, ALABAMA

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Financial support for this project was provided by a grant from NASA*. Lake Harris is a small municipal reservoir located in central Tuscaloosa County, Alabama, on a tributary of the Black Warrior River. Strip mining for coal within the drainage basin of the lake has resulted in the development of two deltas. These deltas consist primarily of

sands and gravels of Cretaceous age and younger, representing overburden removed from the Carter Seam of Pennsylvanian age. Aerial photographs, taken at intervals over a period of thirty-six years, were examined, first revealing the presence of deltas in 1967, one year after mining began. Enlargements from this and subsequent photographs made with the camera lucida were measured by planimeter to determine areas. These figures, together with sediment depths derived from stream profiles from pre-lake and post-deltas topographic maps, allow estimation of sediment volumes in 1974. Attempts are presently being made to project estimates of the volumes of these deltas both in the past and in the future.

*NASA Marshall Space Flight Center, Project Number: NAS8-29937.

POSSIBLE HEAVY MINERAL RESOURCES, OFFSHORE ALABAMA AND MISSISSIPPI

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Economically important heavy minerals have been studied in the sediments of offshore Alabama and Mississippi. Sandy samples have been collected from a 200 square mile area from Dauphin to Horn Islands. The minerals concentrate in sediments under 10-35 feet of water and may reach 2.4% by weight. The distribution of total heavies is related to the hydrodynamics of offshore Alabama-Mississippi; the greatest concentrations are in the Gulf where the longshore current is diverted from its westerly flow. Preliminary observations indicate that the distribution of individual minerals can be correlated with wave energy, particle size, specific gravity, and morphology of the mineral grains. The coarser, lighter minerals--kyanite, sillimanite and staurolite--are concentrated in relatively low energy areas in the Mississippi Sound and at the end of Dauphin Island in the Gulf; maximum concentration for each is 34.5%, 6.0% and 43.2% respectively, of the heavy minerals. The smaller, more dense minerals--ilmenite, rutile, leucoxene, zircon and monazite--are concentrated in high energy areas in the Gulf; maximum concentration for each, respectively, is 42.0%, 5.9%, 9.6%, 10.7% and 1.3% of the heavy minerals. On the basis of a minimum concentration of 1% heavy minerals, two areas have been identified and the total amounts of different minerals have been calculated to a depth of 25 feet of sediment. The data are preliminary and in no way indicate recoverable reserves, but they do show that on the order of 20 million tons of heavies exist. These deposits should be termed "indicated resources".

IRON SULFIDE CONCRETIONS OF THE UPPER CRETACEOUS IN ALABAMA

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Iron disulfide concretions which occur in the upper cretaceous chalks of Alabama were studied to determine their mineral species and time of origin. There is much conflict of opinion in the literature as to whether they are composed of marcasite or pyrite.

Samples were collected from the Demopolis Chalk and Bluffport Marl at 4 locations near Epes in Sumter County. Twelve samples were ground to -200 mesh and analyzed on a Phillips x-ray diffractometer with emphasis placed on the marcasite and pyrite peaks. Specimens were also studied under a binocular microscope for clues to the crystal system and time of formation.

The composition of the unweathered concretions was found to be primarily pyrite. In fact no trace of marcasite was found in any concretion. The surface crystals, which at first appear to be a fine cockscomb aggregate, are actually modified octahedra. Compaction striations and fossil inclusions point to an early diagenetic origin.

FOSSIL SEEDS FROM THE UPPER PARKWOOD FORMATION

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Fossil seeds of the order Trigonocarpales have been found in the upper Parkwood Formation on the northwest slope of Shades Mountain, south of Birmingham, Alabama. Specimens of *Trigonocarpus*, *Polypterospermum*, and *Hexapterospermum* were found associated with *Artisia transversa* and *Calamites*. The fossils were found in conglomerate beds in sandstone containing thin (½ inch thick) beds of coal.

The Parkwood is thought to bridge the gap between the Mississippian and Pennsylvanian systems that is common throughout most of the Appalachian district. These fossils are fairly typical of coal swamp flora of the Carboniferous, but the lack of any distinctively Mississippian fossils does help support the view that the upper Parkwood could be Pennsylvanian in age. More work needs to be done on fossil seeds in Alabama to determine if any of them can be used as stratigraphic markers.

Fossils were found on Interstate Highway 65 south of Birmingham, T18S, R3W, Sec. 26, NE¼, and on Oxmoor Road ½ mile northeast of the intersection of Oxmoor and Shades Crest Roads, T18S, R3W, sec. 34, W½.

FORESTRY, GEOGRAPHY AND CONSERVATION

STILLAGE AS A LOCAL ECONOMIC ASSET IN MOORE COUNTY, TENNESSEE

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A distillery in Moore County, Tennessee, sells spent mash, or stillage, to cattlemen and dairymen within the county. The purpose of this paper is to evaluate the program's economic impact.

A comparative study was made of the Grade A dairy herds which were fed stillage to those which were fed either commercial or cultivated stillage. The results of this comparison indicate a substantial savings in time, money and cultivated acreage are gained by stillage users. This paper also indicates that comparative studies of areas surrounding other distilleries and food processing industries may reveal the presence of or the need for a program such as the one extant in Moore County, Tennessee.

SETTLEMENT PATTERNS ON THE SIDES OF THE MOUNTAINS ABOVE PAINT ROCK VALLEY

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On the sides of many of the mountains in the Paint Rock Valley are the remnants of some of the last log settlement houses to be built in northeast Alabama. These houses represented a way of life that is no longer viable. When most of them were built, 1890-1905, farming was just about the only occupation open to young men and all the easily accessible farm land was taken. Thus, the mountain sides were cleared for farm sites. As life styles changed with the availability of electricity and the automobile, subsistence farming could no longer satisfy the farmer's needs.

GRIST MILLS IN ALABAMA: A GEOGRAPHICAL AND TECHNOLOGICAL APPRAISAL

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By 1830, grist milling in Alabama was a viable and widespread manufacturing enterprise. As settlers moved into the state from Georgia, Tennessee, and the Carolinas, they brought with them centuries of American milling experience in addition to that brought by their forefathers from the continent. Tub mills, undershot and overshot mills, breast mills, and turbine-operated mills were to be found upon nearly every stream in eastern America. Each mill type gradually became adapted to specific water-power potentials. In Alabama, the overshot water wheel and the turbine were the most common means of powering mill gears.

Many questions of a geographical, economical, and technological nature remain unanswered. Attention needs to be focused less on the jolly miller and more on how he decided where to locate his mill, how large his mill was, and of what and how did he build it, how much power did he have and how long could he steadily grind, what influence did he have on establishing roads, what kind of "hinterland" did he serve, where did he get his millstones, and many other pertinent items. This paper focuses upon some of these themes. Unless we can find answers for these and many more questions, our knowledge of milling as an American manufacture will be lost in the swirling mists from "ye olde water wheel."

COTTLE CREEK, A CONECUH RIVER TRIBUTARY, AS AN EXAMPLE OF NINETEENTH CENTURY GULF COAST LOG TRANSPORTATION

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Cottle [or Feagin's] Creek, a small tributary on the east bank of the Conecuh River in north Covington County [Alabama] is an example of a system of water-borne log transportation which the noted forester, Herman Haupt Chapman, described as "a system of transporting longleaf pine logs from woods to mill that has never to my knowledge been used in any other forest region."

The creek drains a none-too-fertile area settled in the 1880's and 1890's where timbermen and homesteaders sought income from the large stands of virgin pine. Railroads did not serve the county until 1900, and transportation posed a great difficulty. The solution, first employed along the Gulf Coast in the 1870's was to straighten and improve the existing streambed by excavation and by construction of timbered retaining walls. Logs were then assembled in ponds and released via gates into the waterway along with a considerable volume of water. Chained end-to-end, the logs floated, or were poled, downstream on this crest until deeper water allowed easier flotation. At a water powered sawmill, operated by Pollard Gantt, the logs were squared and hauled the remaining distance to Sim's Bridge on the Conecuh. There, rafts were constructed and floated downstream in the late fall or winter to the lumber market at Ferry Pass near Pensacola. This practice began in the 1880's and continued until 1914.

Cottle Creek was at the northern limit of raft operations on the Conecuh due to the decreased size of the river and obstacles to navigation. The trip from Sim's Bridge to Pensacola required from three to seven days, but the low cost of transportation allowed attractive profits. Several timbermen parlayed this into considerable landholdings while homesteaders supplemented their meager agricultural incomes. During World War I, the last great stands were cut by large lumber companies which relied on rail transportation, and the pioneer practice came to a close.

FEDERAL EFFORTS TO ALLEVIATE URBAN BLIGHT: COMMUNITY DEVELOPMENT IN ANNISTON, ALABAMA

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One aspect of the Housing and Community Development Act of 1974 funnels money into cities to alleviate urban blight. Some persons contend that a large majority of the block grants are spent to improve the infrastructure outside of blighted areas rather than to alleviate the conditions of blight. A case study analysis of Anniston, Alabama, questions this hypothesis. The study concludes that a large portion of the community development funds in Anniston are spent for recreation rather than for street and sewer improvement. But most of the money is allocated outside blight areas. The study further questions the rationale of city officials who believe that expenditure for recreation outside blight areas improves the total environment of the city and improves its economic standing.

LOCATIONAL ANALYSIS FOR SMALL BUSINESS OPERATIONS: A SUPERMARKET IN SOUTHSIDE, ALABAMA

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Businessmen of small operations require information to determine whether or not a new enterprise would be successful, but they usually do not have the resources to acquire the necessary information. This study represents an approach to analyze a feasible business location without great expenditure of time and money. The location of a supermarket in Southside, Alabama, illustrates the procedure. It is concluded that a supermarket in Southside would be feasible because a large share of the relatively high-income residents travel a long distance to purchase quality food at inexpensive prices. A supermarket in Southside would intercept the expenditure of money outside the community.

YOUTH BASEBALL IN ALABAMA: SOME GEOGRAPHICAL IMPLICATIONS

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Youth baseball in Alabama is widespread, organized, and popular among young and old. A host of programs graded into age brackets aim at standardization and continuity. League locations reflect population distribution, with incorporated places pioneering the movement. Rural or county leagues represent a significant share of the continued growth today. Host communities enjoy intangible benefits, as supervised play activity fulfills recreational needs. Several avenues of tangible

benefits may be realized. Local support and enthusiasm frequently promote the acquisition of additional open park space, the channeling of support funds toward improvement of existing facilities, and the development of a high level of civic pride that may well carry over into all phases of community life.

TOURISM IN THE YUCATAN PENINSULA: PROSPECTS AND PROBLEMS

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The Stephens and Catherwood publication of their "jungle expedition," *Incidents of Travel in the Yucatan,* and soon after the discovery of some key Mayan records first brough international archaeological attention to the Yucatan peninsula in the mid 1800's. The existence of abandoned ruins of the advanced Mayan civilization lost in the lush tropical forests taunted the imaginations of many. Tourism had begun.

The Mexican government intensified efforts to develop tourism in Yucatan in the 1920's. The landscape and the people now exhibit vast contrasts to the traditional way of life. Hotels overshadow the ruins of the Mayan civilization. Modern appliances, televisions, radios, electric stoves, and blenders are finding their way into simple rural huts.

Planners must decide how to distribute growth throughout Mexico and are using area of the Yucatan for resettlement. Jobs must be provided for the increasing population and tourist industry in being developed to bear the burden.

Demands for increased water supply, energy, and other resources are creating other problems. Specialists in the fields of ecology, sociology, medicine, economics, architecture and other related fields have been called in.

Remnant populations of Mayan Indians still live much the way as they did hundreds of years before. But, the sudden influx of curious aliens was bound to affect every element of Yucatecan society in time, from Merida to the rural Mayan descendants.

HOUSE TYPES OF THE YUCATAN PENINSULA AND THE GUATEMALAN HIGHLANDS

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The rural Maya peasant houses of the Yucatan Peninsula and the Guatemalan highlands are folk houses. They are built by men sharing the same cultural traditions. The dwellings they build are reflections of the needs, desires, and world perspective of the people.

In the Yucatan Peninsula three folk types are present based on house form; several subtypes are identified by wall and roof construction. The basic folk types are apsidal, semi-apsidal, and the rectangular.

In the Guatemalan highlands two folk types are recognized according to house form, with several sub-types identified on the basis of wall construction.

Traditional house forms are giving way to different, more modern types with the influx of new building materials and construction techniques. As communication, technology, and urbanism expand in both countries, the rural people are building less traditional "Mestizo" type houses.

THE CONCEPT OF THE SOVEREIGN STATE IN POLITICAL GEOGRAPHY: THE NEED FOR A REAPPRAISAL AND A PROPOSAL FOR CONSIDERATION

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Two events have occurred since 1945 that have created a condition in international affairs that warrants a serious reappraisal of the concept of the sovereign state as the basic political unit of the world community. One is the end of the era of modern colonialism and the other is the creation of the United Nations to coordinate efforts to achieve world-wide peace and economic development.

The end of colonialism has introduced to the world community as sovereign states several extremely small territories whose only raison d'etat is their existence as units of a colonial empire and their subsequent independence. These mini-states now exercise political power far in excess of their size and economic strength.

The United Nations presently has 144 members representing over 96 percent of the world's population. Representation of the mini-states as equal members permits a majority vote to be cast by states collectively, representing only 4 percent of the population. This gross inequity in popular representation gives a citizen of a mini-state such as Sao Tome and Principe, several thousand times the voting power of a citizen of the major powers.

Other writers have suggested schemes for weighted voting in the United Nations. This paper proposes the consolidation of the members of the world community into twenty-six regional federations. The present states would become integral parts of their own federations, but only the federation would be considered a sovereign state for the purpose of membership in the United Nations with voting rights determined on the basis of population, economic wealth and sovereign equality.

THE PROFESSIONALS' ROLE IN CONTROVERSIAL RESOURCE ISSUES

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Professionals in many disciplines must express themselves, unemotionally, on issues affecting the Nation's natural resources. Complacency deprives the public of scientific information on which to base opinions.

Issues discussed included pressure against modern commercial forestry practice by groups of self-termed environmentalists, by an organ of the Socialist Party, and by federal politicians and bureaucrats. Receiving particular attention were the Corps of Engineers, who drafted interim regulations for the Environmental Protection Agency (EPA) to implement Section 404 of the Federal Water Pollution Control Act Amendments of 1972 through a burdensome permit system. Also emphasized was a seminar on "Forest Management Concepts of the Future" sponsored by the Gulf Coast Regional Conservation Committee of the Sierra Club. An attack on state licensing that appeared to degrade the forestry profession and a quotation vilifying American industry and businessmen were included.

INDUSTRY AND ECONOMICS

SYSTEMS FOR DEVELOPING TENNESSEE VALLEY AGRICULTURE

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TVA's agricultural program is one of a number of subsystems which constitute the total system of regional resource development. The TVA Act provided for a long-range program of agricultural readjustment and development, watershed protection, and fertilizer development and use as an integral part of a comprehensive regional program. This program provided for enlistment of the people and their organizations and for cooperation with local, state, and Federal agencies in reaching for the common goal of sound physical, economic, and social development of the Valley. Thus, TVA's efforts were to complement--not replace--the independent economic system.

In 1933, the farming system was generally a subsistence agriculture forming an almost independent and separate part of the economy. The program system used to develop it was a simple one, consisting mainly of a 3-way partnership with the land-grant university, TVA, and selected demonstration farmers. The main thrust dealt with demonstrating to all farmers the effects of improved crop and farm management skills.

By the 1960's the approach had proven effective. But economic conditions had become more complex and were changing more rapidly. A more skillful tool of demonstration and education was developed.

The use of linear programming in farm operation, along with the most advanced technology known by researchers was combined into a new element--the Rapid Adjustment Farm. The audience for its results is professional farm leaders and the time of study is 10 to 15 years ahead rather than present. Thus, the main thrust was changed to influence farmers indirectly through professional leaders.

These farmers have identified fantastic potentials--typically tripling production and doubling net income in four years.

Success of the earlier programs, along with changes in the economy, created new problems for the farm sector. An intensive evaluation of these changes and implications of these was carried out in 1966. The new program added several objectives such as changing the amount of resources the farmer has, land and tenure problems, institutional, environmental, and other restraints.

During the period, the farming system has responded to the program system. By 1973, for example, total food produced had increased from $113 million to $1.5 billion--or 13 times the original output. And, it has done so with fewer resources--about two-thirds of the land and 60 percent of the farm operators.

Working on these problems has created knowledge of the increasing complexity of the farming system and the expanding areas of need for program systems to assist it. New problems recognized for which little guidance is available include.

1. Rural involvement in public land-use decisions effecting them.

2. Emergence of new publics to influence agriculture.

3. Disappearance of food surplus and reemergence of food scarcity.

4. Choice between food and other goals of society.

5. Plight of the limited-resource farmer who has been bypassed by progress.

SCIENCE EDUCATION

AN ELEMENTARY METHODS COURSE BASED ON NEW PROGRAMS, HANDS-ON ACTIVITIES, AND MICROTEACHING

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The elementary methods course is described which involves students in selected activities from Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS), Science - A Process Approach (S-APA), Unified Science and Mathematics for Elementary Schools (USMES), and Elementary Science Study Program (ESSP) (BSCS New program).

The microteaching sessions using four to eight elementary students in each session are described.

A demonstration of one of the activities from the ESS unit "Kitchen Physics" is demonstrated.

OPERATIONS AND SERVICES OF THE NATIONAL NETWORK OF AEROSPACE SCIENCE EDUCATION RESOURCE CENTERS

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With one center located in Alabama (Auburn University) and two centers in Georgia (Columbus College and Georgia State University), the national network of aerospace resource centers offers services to teachers, school administrators, guidance and counseling personnel, Curriculum consultants, and to a limited number of non-school-connected professionals. Consultative services, curriculum materials, science project guidance, and assistance with the organization of new programs in aerospace science are typical of the requests for service which are received by the Aerospace Education Resource Centers.

The AERC at Columbus College provides a permanent reference library and media collection containing films, slides, filmstrips, study prints, models, books, pamphlets, charts, magazines, and other print and non-print items. Materials of a non-permanent nature, many of which are secured in bulk quantities are usually given to interested patrons of the center. A referral service is provided for questions and requests not immediately available locally.

The network of AERC's, with over one-hundred-twenty-five (125) centers virtually covers the entire fifty states. Plans are underway to expand the number of centers as well as the spectrum of services to be rendered.

Among the several organizations which support the AERC network are the General Aviation Manufacturers' Association, the Civil Air Patrol, the Federal Aviation Administration, the National Aerospace Education Association, and the National Aeronautics and Space Administration.

A REPORT ON THE AAAS PROJECT ON THE HANDICAPPED IN SCIENCE

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Martha Redden is the director of this project which proposes to locate handicapped scientists, listen to their problems and, where possible, provide assistance.

One of the first activities is to remove barriers such as curbs that can't be crossed by wheelchairs at professional meetings-beginning with the current AAAS meeting. Also special audio-visual aids and even assistants will be provided.

The project points out that there are many outstanding scientists who are handicapped and yet have made a significant contribution. The project plans to give them a better chance to compete for advancement.

The author requests that help for the handicapped AAS members be provided at our meetings.

ORBITS, THE CALCULATOR, AND THE NON-CALCULUS PHYSICS LABORATORY

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Students in a non-calculus based physics laboratory "solve" the problem of a satellite in orbit about the earth, using their pocket calculators. In order to increase the speed of computation, the same computational steps are then programmed on a full size computer and the printouts of position are plotted in laboratory for a visual presentation. This "Play Houston Control" project strengthens their confidence in being able to handle involved dynamical situations, and it fosters a much needed understanding of the usefulness and limitations of the digital computer. Colleagues are encouraged to exploit the recent population explosion of pocket calculators.

SOCIAL SCIENCES

AN APPROACH TO COMMUNITY STUDY: A CASE STUDY OF MERCHANT CASTES IN TWO INDIAN CITIES

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The revived interest in community studies in the United States and especially in regions such as the South, confronts social researchers with numerous dilemmas among which is the problem of boundaries. With few exceptions (e.g., Vidich and Bensman, 1960; Martindale and Hanson, 1969), the recognition of trans-local forces operating in community affairs has been either absent or treated in a secondary fashion. Researchers of India's towns and cities (e.g., Hazlehurst, 1966; Fox, 1969, *et. al.*) have developed more comprehensive perspectives which may be valuable to U.S. researchers. This is illustrated by making a substantive comparison of merchant castes of two Northern Indian cities which have been detailed by Hazlehurst and Fox.

FREDERICK, PRINCE OF WALES: CAUSES AND METHODS OF OPPOSITION

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Neither Frederick nor George II was tactful in working together. Several factors contributed to Frederick's joining the Opposition. He was unhappy about receiving a smaller financial allowance than his father had had as Prince of Wales. Failure of George II to arrange a suitable marriage for the prince was another complaint. Frederick was also bitter over being denied for many years a separate residence. The prince was angry because his brother, the Duke of Cumberland, obtained military commands while Frederick was refused a command. Another complaint was that Frederick was never allowed to serve as regent while the king visited Hanover.

Frederick's ability to form his faction in Parliament was based on his allowance being raised in 1742 to £100,00 per year and his having additional revenues from the Duchy of Cornwall. He used these funds to increase the posts within his household, some of which were filled with members of Parliament.

The prince's death in 1751 destroyed plans to have members of his personal faction eventually assume posts in the British government upon his accession. Frederick's faction was quickly dissolved by Princess Augusta, who won the favor of George II in order to make life for herself and her son more comfortable.

ALABAMA'S BLOODIEST DAY OF THE AMERICAN REVOLUTION: COUNTER-ATTACK AT THE VILLAGE, JANUARY 7, 1781

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Between the Spanish capture of British Mobile on March 14, 1780, and the surrender of General John Campbell at Pensacola in May, 1781, a bloody skirmish took place at a fortified outpost some eight miles from Mobile. José de Ezpeleta, the Spanish commandant at Mobile, reported on three early efforts of British and German troops from the Waldeck Regiment to harass the outlying settlements and a British naval attempt to "liberate" the Spanish beef herds on Dauphin Island. In the Spanish garrison at The Village there were 190 men from the Spanish line infantry regiments (Príncipe, España, Navarra and Havana), several gunners from the Royal Artillery Corps, and black troops from the New Orleans Colored Militia Companies. The British attacking force included 60 men from the Waldeck Regiment, originally "hired" by George III to fight the Americans in 1776. Colonel J. L. W. Hanxleden, their commander, took to the field along with West Florida Royal Forester rangers, Maryland and Pennsylvania Loyalists, and 100 select soldiers from the 60th (Royal American) Regiment of Foot. On the morning of January 7, 1781, under cover of stormy night and poor visibility, the British forces infiltrated the advance Spanish positions manned by the black troops. Sublieutenant Manuel de Córdoba of the España Regiment realized too late that the dimly-seen shapes were the enemy and not his own men; he paid for his error with his life. After an initial advantage, the British attackers could not dislodge the defenders, who rallied and threw back their tormentors in furious hand-to-hand fighting. William Augustus Bowles, who fought side-by-side with the Creek Indians he would later lead in the Free State of Muskogee, fired from protection of a tree, until a Spanish cannon ball splintered his protection into pieces. A Waldeck major rushed the Spanish line with such fury that he was impaled on a bayonet. The British forces retreated to Pensacola leaving at least 18 dead and 60 wounded among whites and some 7 Indian auxiliaries in the casualty list. The Spanish defenders lost 14 killed, 23 wounded, and 1 prisoner. The *Gazeta de Madrid*, April 6, 1781, printed the official reports and the rewards given to heroic Spanish defenders. Some earned promotions, pensions, posthumous eulogies, and the blacks earned silver medals and certificates of merit. Mobile was now safe, and Pensacola's last serious defensive maneuver had been thwarted. It was Alabama's bloodiest single day in the American Revolution.

CHURCH SIZE AND MEMBERSHIP GROWTH

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In the early years of the Colbert-Lauderdale Baptist Association most churches were small and growth was more rapid than in recent years according to data in the 1974 minutes of the association.

Abstracts

Until about 1950 there was an average annual growth by baptism of about five new members for each 100 old members. New churches were formed so that the average number of members per church had grown to only 210 by 1950. Since 1950, the growth in new churches has been slower so that members per church is 375. Baptisms per 100 members has declined since 1950--from a high of over 6 to about half that.

There is a wide range in church size--six have less than 100 members while five have over 1,000. There is a wide range in rates of growth by baptism. Churches with less than 100 members averaged 100 members in 1974. Rate of baptisms declined sharply with size; those with over 1,000 members averaged only 2 baptisms per 100 members.

All size groups had net growth. Churches with under 200 members added more than twice their losses, but churches with over 500 members gained only a third more than their losses.

Comparing losses to baptisms is even more dramatic. Churches with less than 200 baptised more than total losses. Churches with over 200 members would have had net losses in membership had it not been for transfers from other (smaller) churches. Churches with over 1,000 members replaced less than half of their losses with their own converts!

Seven churches were organized during the last 10 years. They had a combined membership of 1,001 and a net growth of 143. Their growth was made up of 112 baptisms and 63 other additions less 36 losses. Their rate of baptisms is over three times the average for the association and the net growth is over five times the association average.

It is clear that small churches are growing faster than larger churches--especially by baptisms. The importance of growth by baptism and its dramatic relationship to size is reason to raise some serious policy questions:

Are there advantages of larger churches that justify the sacrifice in growth by baptism?

Should larger churches adopt positive programs of establishing new churches?

Should the association be more active in forming new churches and missions as part of its mission effort?

Would individuals become more effective evangelists if they move to smaller churches?

A STATE OF FLUX: BLACK LABOR IN ALABAMA, 1860-1865

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To examine and comprehend the enormous task of reconstructing the labor force in Alabama following the Civil War, it is necessary to consider the state's changing social, economic, and political conditions from 1860 to 1865. As Confederate governments crumbled, Alabama lapsed into political turmoil. Economically the war's toll was devastating. Between 1860 and 1865, black labor underwent the transition from slavery to freedom. For Alabama and the defeated South to recover economically, the question regarding the type, availability, and source of labor had to be resolved.

Prior to the Civil War, Alabama's economy was predominantly agricultural and dependent upon the cultivation of the commercial cash crop, cotton. Slaves were naturally concentrated in the area where the cotton plantation system dominated. By 1860 Alabama slaves numbered approximately 435,000 and comprised 45% of the state's total population.

In early 1861, Alabama seceded from the Union which led to active involvement in the Civil War. It was apparent from the beginning of the war that Alabama slaves would play an important role in the struggle. Bondsmen comprised the major labor force in the production of foodstuffs, arms, munitions, and fortifications. The condition of institutional slavery remained generally unchanged outside of the Tennessee River valley until the latter part of the war when Union troops occupied the interior of Alabama.

Although welcomed as laborers, the controversy over the use of Alabama blacks as soldiers in the Confederate army was not settled until March, 1865. Finally the Confederate Congress authorized the enlistment of blacks, free and slave, in the army as troops. But since this action came so close to the end of the war, few blacks were mustered into service, although theoretically the adoption of such a policy had a deleterious effect on the control of slaves.

The labor force in Alabama and the relationship between master and slave was further dismantled by the progressive occupation of the state by federal troops. Slaves flocked to Union lines seeking liberation and refuge. By April, 1865 Alabama's labor force was in a state of confusion. Thousands of slaves were put out of work by the destruction of Confederate munitions factories while others left growing crops unattended to follow the invading army. Alabama's black belts swarmed with slaves who joyously waved to passing Union troops in anticipation of being freed.

THE ESTABLISHMENT OF THE NATIONAL LABOR RELATIONS BOARD AND ITS EARLY HISTORY, 1935-1938

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The paper traces developments leading to the establishment of the present National Labor Relations Board in 1935 and the early years of its existence. Attempts by the federal government to strengthen the labor movement became prominent in the period of World War I as the government attempted to stabilize labor relations during this critical period. Indicative of the government's efforts, in this regard, was the establishment in 1918 of the National War Labor Board. In the early post-war period the Railroad Labor Board was created under the Transportation Act of 1920.

Finally in 1933, by executive order of President Franklin Roosevelt, the National Labor Board was created to implement labor policy under the National Industrial Recovery Act. This Board's authority expired within one year but a Joint Resolution granted the President power to appoint a National Labor Relations Board in 1934. In 1935 the National Labor Relations Act was passed creating a National Labor Relations Board with broad powers. It drew on the staff of the previous Board (1934); ultimately its constitutionality was upheld in a series of five decisions rendered by the Supreme Court in 1937. Thereafter the Board's activity increased; however, it was a target of criticism by the American Federation of Labor (AFL) due to the schism in the ranks of the AFL after the creation of the Congress of Industrial Organization (CIO) and charges by the AFL that the Board favored the CIO in representation elections.

INTERPRETATIONS OF ALEXANDER HAMILTON: A SURVEY

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No statistical study has yet appeared which attempts to determine whether more has been written about Alexander Hamilton than about any other historical figure. In the absence of such data, the student of Hamilton historiography must be content with the statement that there is a wealth of material concerning Alexander Hamilton, most of it regrettably biased and tendentious. Hamilton, an outstanding figure in an age of political giants, has aroused as much scholarly and popular interest as any president among his contemporaries, and has provoked more speculation than most later presidents. Admiration or antipathy characterizes most of the commentaries about Hamilton, a circumstance which testifies as much to his historical significance as to his enduring controversiality.

Many books are ranked as milestones in Hamilton biography and interpretation, but, to date, Hamilton historiography shows no definitive work, if its test be objectivity, impartiality, and knowledge, combined with skill in the presentation of that knowledge. It is unfortunate that most biographers, in choosing a protoganist, feel it incumbent upon themselves simultaneously to choose either a hero or a villain. Classics of subjectivity have thus been produced, but a moderate, objective study has yet to be written; review of the literature reveals a but few attempts to fulfill this criterion.

THE INTERRELATIONSHIP OF ACADEMIC DISCIPLINE, WORK AND LEISURE PREFERENCES AMONG UNIVERSITY PROFESSORS

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The sociological literature suggests that some occupations stress particular orientations, *i.e.*, object and/or people. These same orientations may find expression in leisure activities, and the hypothesis can be raised that occupation influences leisure activities by serving as leisure training devices however unintentional this may be.

The basic concern of this research is: 1) to identify the work and leisure preferences shared by persons in a particular occupation and in a particular academic discipline, and 2) to ascertain to what extent work preferences affect leisure preferences.

Using a study population of 317 university professors at a large university, four major disciplinary areas were sampled including engineering, education, humanities, and natural sciences.

Occupational and disciplinary influences are viewed as intervening variables affecting the relationships between socio-demographic and organizational factors and aspects of work and leisure. Utilizing Gamma as a measure of association the stated relationships will be tested.

CUBAN SUGAR AS A PRODUCT OF NINETEENTH CENTURY CAPITALISM

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With the development of the *central*, the extremely large sugar mill which may or may not have included cane fields, Cuba entered upon a most dynamic period in her history. During this period the sugar industry

became entirely a capitalistic enterprise with its enormous investment in expensive, elaborate machinery and its own railroads.

About 1834 there were approximately eleven hundred mills of all types on the island; by 1846 the number increased to 1,442; by 1850 there were more than 1,750. By 1858, the number of mills of all types was reduced to about 1,500, producing an average of twenty thousand *arrobas* of sugar annually, or about 500,000 pounds each. According to the 1846 census 286 of the 1,442 mills were using steam power. Most of these were located in western and central Cuba, where geographic factors were most favorable for capital development.

One of the first American firms to make substantial investment in the Cuban sugar industry was E. Atkins and Company of Boston. It acquired the Soledad plantation from the Sarria Family in 1883, when it could not pay its debts. The plantation was enlarged and equipped with new machinery. Hugh Kelly and Franklin Farrell were the second United States citizens to invest heavily in the Cuban sugar industry. They established the *Central Santa Teresa* near Mansanillo, an estate of nine thousand acres. In 1902 the investment in this *Central* was estimated at $1,565,000. In 1893, the Rionda family and New York sugar merchants established the Tuinucua Cane Sugar Company that operated near Sancti Spiritus.

By 1895 the initial development of the sugar industry by nineteenth-century capitalistic enterprise was accomplished, thereby laying the groundwork for much closer control of Cuba and her sugar market by the United States, as the latter nation left her traditional policy of non-intervention and non-colonization.

THE GREAT GERMAN NAVAL LAW OF 1900: TRIPITZ VS. BEBEL

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The very popular Second German Navy Bill of 1900, which made possible the construction of a potentially offensive Battle Fleet, threatened utterly to alienate England and isolate Germany. This alarming prospect persuaded August Bebel, leader of the Social Democratic Party, to assail the bill not merely as a curtailment of the power of the Reichstag but, what was far worse, as a threat to peace. Bebel believed that the schemes of Admiral von Tirpitz, Chief of the Naval Office, would drive England into alliance with France and Russia against the Reich. Castigating the profit motives of the agrarian-industrialist parliamentary bloc behind the bill, Bebel advocated an alignment that would link the greatest fleet and the best army in the world. He urged the feasibility of an Anglo-German alliance and asserted that Germany did not need a Battle Fleet and would in no case be able to build one that could match the British.

After acceptance of the Second Navy Law a desperate but never despairing Bebel continued to fight the "Tirpitz Plan." After he had undermined the agrarian-industrialist Bülow Bloc that had supported it, he

caused Tirpitz to modify his plan in important essentials. Bebel in the years 1906-1912 hoped that he would be able to dampen the enthusiasm of Junkers and industrialists for further huge naval expenditures by demonstrating that they would virtually bankrupt the treasury and necessitate direct taxes which would be anathema to the rich. With these initiatives, however, Bebel won only Pyrrhic victories. They came too late to allay British enmity or to save the Socialist Party from betraying its principles.

MEDICAL SCIENCES

BIOLOGIC CONSIDERATIONS OF LIFE AT AN ADVANCED AGE

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Venerability has been a quality admired by man throughout recorded history. Rejuvenation of lost function has veen a recurrent dream. The concept of growing old strikes each somewhat differently, even at different stages of life. Affectively, *old age* means decrepit or functional impairment. Yet, does "advanced age" really mean OLD? What are the biologic signs accompanying increasing years of life?

To name a few, they are decreased basal metabolic rate; increased susceptibility to fluctuations in environmental temperature; decreasing ability in visual accommodation; decline in reproductive function; and a number of different neurological complaints ranging from "numbness" to impaired cerebration. Advanced age is a stage of life but is not a disease; probably no one has died of old age in a comparable way to a myocardial infarct, hemorrhage, etc.

Are there signs which indicate the physiological age of an individual? Although there have been a few indicators such as graying of hair; loss of hair; wrinkling of skin, the basic biological alterations producing these is unknown; neither do they lead to impaired function.

One concept which recurs in the history of aging research is that aging perhaps is an extragonadal hormonal deficit. However, when modern techniques measured these plasma hormone concentrations, no alteration as a function of age was found, except for the gonadal hormones. After this revelation, the concept was changed to a relative tissue insensitivity to the hormone, perhaps due to one of the following:

(1) Failure of the hormone to be released from its plasma transport form in the tissue capillaries (or less readily released) with age;

(2) The cell receptors become structurally altered so that more hormone is required to interact to give the same effect as in a younger person;

(3) Some cell receptors drop out in aging so that a higher hormone concentration is required to increase the probability of interaction with the fewer remaining receptors;

(4) Production of an antagonist to the hormone begins as a function of age and its plasma concentration increases progressively.

The questions remain to be answered: do cells finally "wear out"? is there an instability in the genetic apparatus, which within rather narrow limits for a given species, gives some lethal change? is there a gene programming impending dysfunction by producing an inhibitor of a hormone as a function of age? or what?

DEOXYRIBONUCLEASE INDUCTION IN WISH CELLS INFECTED WITH HERPES SIMPLEX VIRUS TYPE 2

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Herpes simplex virus Type 2 (HSV-2) has been implicated as the etiological agent in cervical cancer. Demonstration of the induction of a new deoxyribonuclease (DNase) in cells infected with HSV-2 would lend further support to the hypothesis that the virion DNA is integrated into the host cell genome. Cell-free extracts were prepared from non-infected WISH cells and from cells 2-24 hr after infection with HSV-2. DNase activity was assayed using both double stranded (ds) and single stranded (ss) tritium labeled HeLa cell DNA. Deoxyribonuclease activity in non-infected controls did not vary over the 24 hr period. There was an increase in activity in the infected cells which peaked at 8 hr after infection and was 4-fold greater in the nuclear fraction than in the cytoplasmic fraction. An 18-fold increase in DNase activity with specificity for ds DNA was observed in the infected cells while only a 2-fold increase was seen when ss DNA was the substrate. Subsequent to HSV-2 infection a new DNase(s) with a high specificity for ds DNA is found in the infected cell, thus providing a means by which all or part of the HSV-2 DNA could become incorporated into the host cell genome, potentially causing the formation of new cell products which may free the cell from normal growth regulating mechanisms.

IN VITRO TRANSCRIPTION OF GLOBIN mRNA FROM RABBIT MARROW CHROMATIN

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In order to reconstruct the cellular events which accompany eukaryotic gene expression, the highly restricted chromatin from rabbit

erythroblasts has been used as a template for RNA synthesis. DNA-dependent RNA polymerase II isolated from calf thymus has been used to transcribe the available genes. As a precaution, nascent pre-mRNA fragments have been removed from the erythroid chromatin; a portion of these fragments have been observed to serve a messenger RNA function and be translated into protein when these polynucleotides are modified by subsequent enzymatic formation of 7-mG5'-ppp-5'Np(Np)n termini. RNA transcripts synthesized *de novo* exhibit these same characteristics. Current investigations of this reaction indicate these enzyme activities appear to be restricted to the eukaryotic cell cytoplasm, and this reaction then offers a rapid, and sensitive measure of messenger RNA transcription. Because of this requirement for post-transcription modification in subsequent protein synthesis, this reaction offers a potential site at which gene expression might be controlled.

HEAT LABILITY OF TWO ENZYMES OF RAT LIVER MITOCHONDRIA

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We were intrigued by Holliday and Tarrant's report (*Nature 238*:26-30, 1972) that glucose-6-phosphate dehydrogenase and 6-phosphogluconate dehydrogenase from cultured fibroblasts subjected to many passages contained thermolabile components absent from early-passage cells. Since we are studying enzymatic activities in mitochondria from rats of different ages, we decided to measure the heat denaturability of succinate dehydrogenase and glutamate-oxalacetate transaminase in these liver mitochondria.

Because it is often necessary to store samples frozen, we had to determine the effect of this on enzymatic activity. For at least 80 days, frozen storage did not affect the enzyme activities.

For the heat denaturation experiment, aliquots of twice-frozen preparations, diluted 10-fold with deionized water, were dispensed into capped tubes; a rack containing these tubes was plunged into a water bath at 50 ± 0.05°C or 55 ± 0.05°C. At timed intervals, tubes were removed and plunged into an ice-water bath.

Average rate constants (±their standard errors) of thermal denaturation are:

GOT 50^{o}C (5 exp) 0.059±0.009 min^{-1} 55^{o} (3 exp) 0.237±0.043 min^{-1}

SDH 50^{o}C (5 exp) 0.107±0.021 min^{-1} 55^{o} (3 exp) 0.169±0.046 min^{-1}

These experiments have not indicated an extraordinarily thermolabile component.

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HYDROLYSIS OF A SYNTHETIC AMIDE SUBSTRATE BY HUMAN C1 ESTERASE

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The hydrolysis of a synthetic amide substrate by C1 esterase ($C1\bar{s}$) is reported. Highly purified $C1\bar{s}$ hydrolyzed N-benzoyl-L-phenylalanyl-L-valyl-L-arginine p-nitroanilide (BzPheValArgNA) but did not hydrolyze either N-benzoyl-DL-arginine p-nitroanilide or N-acetyl-L-tyrosine p-nitroanilide. Activity toward BzPheValArg NA during the purification of $C1\bar{s}$ (including two cycles of ion exchange chromatography and one cycle of gel filtration) correlated with elution profiles for $C1\bar{s}$ determined by optical density measurements at 280nm and esterolytic assays using N-carbo-benzoxy-L-tyrosine p-mitrophenyl ester, a known substrate of C1 esterase. Treatment of purified $C1\bar{s}$ with diisopropylphosphorofluoridate resulted in progressive and parallel losses of activity toward both BzPheValArgNA and N-carbo-benzoxy-L-tyrosine p-nitrophenyl ester. Kinetic analysis yielded a K_M of 0.36mM and a k_{cat} of 5.7 min^{-1} for the hydrolysis BzPheValArgNA by $C1\bar{s}$. Additionally 0.7mN benzamidine was observed to behave as a non-competitive inhibitor of the $C1\bar{s}$-catalyzed hydrolysis of BzPheValArgNA. These results suggest that the restricted proteolytic specificity of C1 esterase may derive from a requirement that amide substrates possess specific amino acid sequences capable of interacting with multiple binding sites on the $C1\bar{s}$ molecule. (Supported by NIH Grant #5 RO1 AI11527)

WILLIAM BEAUMONT: PIONEER BIOCHEMIST

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William Beaumont was born November 21, 1785 in Lebanon, Connecticut. He never attended college or a school of medicine. He read medical works while teaching school at Champlain, N. Y. and decided to seek an apprenticeship with Dr. Benjamin Chandler at St. Albans, Vermont. The Third Medical Society of the State of Vermont granted him a license to practice medicine in June 1812 after a two year apprenticeship. War with England began in 1812 and Dr. Beaumont entered the U.S. Army as Surgeon's Mate. His commission was issued by President James Monroe on December 2, 1812. The Treaty of Ghent was ratified in February 1815 and the U.S. Army was reduced in numbers. Dr. Beaumont and a partner opened a general merchandise store in Plattsburgh, New York in December 1815 and he sold the business in December 1816. Dr. Beaumont entered the private practice of medicine in Plattsburgh in the Inn of Isreal Green. However, the call of the Army was so great that Beaumont accepted a commission as Post Surgeon, Fort Mackinac, Michigan Territory. President Monroe signed the commission on March 18, 1820. Dr. Beaumont

returned to Plattsburgh and marrked Isreal Green's daughter, Debra, who had been a nurse during several of the battles with the English.

The American Fur Co. had one of its principal stores on Mackinac Island where trappers brought their furs. One June 2, 1822, a young French Canadian, Alexis St. Martin, was wounded by a shotgun at close range while in the store. Dr. Beaumont was called from the Fort and he treated St. Martin. The wound left a hole in the stomach and Beaumont attempted to close the aperture but he was not successful. The stomach wall attached itself to the abdominal wall and that made it possible to introduce various foods into the stomach. So after treating St. Martin for three years in his home, Beaumont decided to begin a series of experiments to determine the time it would take to digest various foods. At first he introduced foods tied on a string. Later on, he put foods in muslin bags before introducing them into the stomach. He noted the time for digesting a large variety of foods: Beef, chicken, mutton, pork, veal, oysters, turkey, potatoes, slaw, corn bread and wheat bread. He noted that the fasting stomach did not contain gastric juice but that irritation could produce a flow of juice. He observed that ardent spirits produced dark spots on the stomach mucosa. He also noted that when oysters were introduced through the aperature, that hunger sensations were allayed.

SIGNIFICANCE OF *DIPETALONEMA RECONDITUM* FILARIASIS IN DOGS

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Infection with filarial worms (filariasis) is a health problem in both animals and man throughout the warmer regions of the world where the necessary arthropod vectors occur. It has been calculated that at least 6% of the entire human population is affected with filariasis.

One of the most serious diseases that affects dogs is canine heartworm disease, caused by the filarial worm *Dirofilaria immitis.* A second filarial worm, *Dipetalonema reconditum,* frequently occurs in dogs but is believed to be relatively nonpathogenic. Evidence has been found which suggests that *Dipetalonema* infection may be antagonistic to *Dirofilaria* infection. The purpose of research now underway, or being devised, is to more clearly define possible antagonistic effects of *Dipetalonema reconditum* in heavy experimental infections, and to more clearly define the life cycle of the worm.

A METHOD FOR MEASUREMENT OF TIDAL VOLUME IN THE RAT

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A low resistance pneumotachograph was developed to measure ventilation of the rat. During ventilation a pressure difference was produced across an internal resistance. This pressure difference was measured with a differential pressure transducer. The electronic signal produced during expiration was electronically integrated, and the time required for the integrating circuit to reach full capacitance was noted. This time was related to gas flow.

Calibration of the pneumotachograph was done with a small animal respirator. This respirator closely approximated animal ventilation and allowed for independent variation of tidal volume and frequency. Tidal volume, frequency and integration time were related by a Statistical Analysis System computer program. The computer-derived mathematical model could then be used with animals to predict tidal volume from respiratory frequency and integration time.

This model was used to predict ventilation of the rat in both the basal and stimulated condition. The predicted values for ventilation agreed well with values obtained by others.

THE REGIONS OF THE FORNIX LONGUS: A MORPHOLOGIC ANALYSIS

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To elucidate further the relationships between the septal area and the hippocampal formation, combined electrophysiological-morphological analyses have been made of the dorsal fornix or fornix longus. This fiber system is first noticeable near the dorsal psalterium and courses rostrally near the midline. Arching over the ventral psalterium, the fibers enter the postcommisural fornix to distribute to the mamillary bodies and anterior thalamic complex.

Stimulating and recording electrodes were placed on the fornix longus area of the cat after it had been surgically isolated from its surrounds. This isolation procedure separated the fornix longus from its connections with the septal region and hippocampus. Recovery periods for the bundle were obtained and demonstrated a longer period than should be found in a pure fiber system. To further understand this problem, cell analyses were made.

Modified rapid Golgi impregnations of the rodent fornix longus region revealed several explanations for this increased recovery period. Both interstitial and bed nuclei accompany the fornix longus throughout its course. The bed nucleus starts in the region of the alveus and stratum oriens of the dorso-rostral hippocampus. Throughout its extent, numerous fibers can be seen coursing with this bed nucleus. The septal end of the bed nucleus is usually referred to as nucleus septo-triangularis. The combined physiological-morphological data of the present report suggests that the total complex should be referred to as the bed nucleus of the fornix longus. This nucleus, along with the related interstitial nucleus, appears very important to the relationship of the hippocampus to the septal area, notably the magnocellular medial septal region.

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THE LIMBIC-ISOCORTICAL INTERFACE

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Historically, the relationship of the medial cerebral hemisphere to the foramen of Monroe has been well documented since the 17th Century. However, the interrelation between medial allocortical and lateral isocortical telencephalon is poorly understood. The work of the Vogts in the early 20th Century and subsequently, the recent work of Sanides has defined the circumferential transition between the two, - the proisocortex. The gross morphology suggests the possibility of a diffuse input system from isocortex to allocortex through the medium of the proisocortex.

Area 35 (proisocortex of hippocampal formation) lesion shows a specific input to the dentate fascia. Preliminary studies using HRP (horseradish peroxidase) injected into the cingulate gyrus reveals a somal uptake of the enzyme in the adjacent proisocortex. Of note is a preponderance of the uptake in layer III cells of proisocortex, the lamina used to differentiate proisocortex.

This observation lends further support to the concept of a diffuse circumferential input to allocortical structures from isocortex through the proisocortical interface.

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THE HIPPOCAMPO - ANTERIOR THALAMIC CONNECTION: A HORSERADISH PEROXIDASE STUDY

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While the projection from the hippocampus to the anterior thalamus was described nearly 100 years ago, the location of the efferent cells within the hippocampal formation is unknown. Discrete lesions in the different subdivisions of the hippocampus suggest that the efferent cells are not in the hippocampus proper (i.e. CA1-CA4), but rather they are in the subiculum, presubiculum, parasubiculum or entorhinal cortex. To avoid localization problems inevitable with the lesion method, this study utilized a retrograde labeling method with horseradish peroxidase (HRP) to study this connection. Injections (.01 to .05 microliter of 20% to 33% HRP) were made in the anterior thalamus of rats. Also control injections were made in the habenula, dorsal hippocampal formation, and cingulate gyrus.

Following injections which included the anterior thalamus, labeled cells were evident in the perialvear layer of the subiculum and presubiculum. No labeled cells were found in the allocortical hippocampus proper or other periallocortical structures. In the control injections, cells were not found in the perialvear subiculum or presubiculum but were evident in the outer layers of the presubiculum, parasubiculum and entorhinal cortex.

Therefore, it is concluded that these perialvear cells are the primary source of the hippocampo - anterior thalamic fiber pathway. The role of this projection in the reciprocal connections of the hippocampus and anterior thalamus will be discussed.

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THE DENDRITIC ORGANIZATION OF THE RODENT NEOSTRIATUM

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In recent years evidence has accumulated indicating significance in types of electrochemical activity other than classical synaptic activity in the central nervous system. The ephapse or electronic junction, the dendro-axonic synapse and dendro-dendritic synapse have seriously complicated our previously held, rather simple notions of neuronal interactions. The discovery of dendritic bundles which are composed of closely apposed dendritic processes has added more weight to the growing mass of questions

concerning neuronal activities.

The nucleus magnocellularis of the reticular formation, the reticular nucleus of the thalamus and the cerebral cortex have been identified as having dendritic bundling. Using a modified Rapid Golgi impregnation, we have shown dendritic bundling to be a characteristic of the adult rodent neostriatum. Ontogenetic studies indicate bundling in the neostriatum develops within thirty days of birth in the rat. Concommitant with the development of the dendritic bundles is a redistribution and proliferation in the dendritic or somatic spine population. This is in contrast to the bundling in the reticular formation which forms spineless dendritic bundles which were spinous at birth. Investigations currently underway indicate bundles occur in the ventral anterior nucleus of the thalamus. It therefore appears that bundling occurs in proximity to the internal capsule in the rat. Further anatomical and electrophysiological studies are required to evaluate the significance of the spinous dendritic bundling in the neostriatum as compared to aspinous bundling elsewhere. It may be related to the predominance of intrinsic synaptic connections characteristic of the neostriatum.

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REGENERATIVE CAPABILITIES OF THE FOREBRAIN IN THE TELEOST FISH

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Morphologic studies were made of the regenerated telencephalon in the Japanese Carp, *Cyrpinus carpio*. Three-inch long Japanese Carp were sacrificed at both 40 and 70 days following extirpation of the telencephalon. 75% of the operated fish showed partial to complete regeneration of both hemispheres. Data showed that a small bud of neural tissue left at the posterior aspect of the telencephalon, during surgical removal, promoted enhanced regeneration.

Following impregnation with modified rapid Golgi techniques, the tissue was sectioned at 120 microns and analyzed for cellular detail. Regenerated neurons of the telencephalon showed no major morphological changes from the normal teleostean telencephalon. Spine counts, the shape of the axonal processes and dendritic field measurements were similar to controls. However, lack of an anterior commissure was noted in all regenerates, as well as asymmetric growth of hemispheres in 20% of the

experimental animals.

Several dense layers of cells were noted along the ventricular walls, with a majority of processes from these cells displaying soma-like masses toward the distal end. These masses, which are thought to represent initial stages of newly formed neurons, appear to add support to the theory, that these cells may still maintain their embryonic pleuripotentiality of the primitive mantle layer, and may be responsible for the replacement of the extirpated telencephalic tissue.

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SOLUBILIZED ENZYMES AND PROTEIN PATTERNS OF BOVINE FETAL AND ADULT PLASMA MEMBRANES

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In recent years the plasma membrane of mammalian cells has received much attention due to the many functions it is known to perform as an integral component of the cell and to the activities that the cell surface may contribute during the developmental process. For these reasons, comparisons of enzymatic and protein patterns of adult and fetal bovine liver plasma membranes were analyzed.

The plasma membranes were isolated and purified by integrating various techniques of centrifugation. Preliminary fractionation of the cellular components was accomplished by differential centrifugation in isotonic sucrose. The plasma membranes were then isolated by zonal centrifugation in the B-XIV zonal rotor utilizing a discontinuous sucrose density gradient. This resulted in the isolation of two distinct plasma membrane subfractions differing in both enzymatic activity and protein composition. Plasma membrane marker enzymes were assayed and the activities between the fetal and adult membranes were compared.

The proteins of the adult and fetal plasma membranes were also analyzed by SDS containing polyacrylamide gel electrophoresis. Densitometric analysis of the gel patterns revealed differences in the protein composition of the adult and fetal stage plasma membranes. These results show that the fetal and adult plasma membranes are dissimilar and these differences may reflect functional roles that the membrane performs which are unique during these two stages of development.

ELECTROFOCUSING ANALYSIS OF BOVINE PLASMA MEMBRANE SOLUBLE COMPONENTS ISOLATED BY A VARIETY OF SOLUBILIZATION TECHNIQUES

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Plasma membranes from adult bovine liver were isolated using discontinuous sucrose density gradient followed by a floatation procedure as described elsewhere (1). The membranes were isolated in two fractions (vesicular and sheet forms) based upon differences in density. Both the heavy sheet (density 1.175) and light vesicular (density 1.14) fractions were solubilized in either 0.9% NaCl, 0.1% Triton X-100, 1% deoxycholate, n-butanol or 1% cholate to remove non-residual proteins. The extracted protein fractions were analyzed by isoelectric focusing to compare the relative effectiveness of each solubilizing agent.

Generally up to 85% of plasma membrane proteins can be solubilized but different agents work with different effectiveness on membranes from different sources. In addition, solubilizing agents sometimes are difficult to remove from the extracted proteins and thus interfere with analysis by techniques such as isoelectric focusing. In this study, n-butanol apparently extracted proteins but caused severe dehydration of the acrylamide gel at power ranges required for focusing. Physiological saline yields one major band focusing at pH 4.5-5.0 and appears to be albumin-like. Deoxycholate and cholate yield 6 and 4 major bands, respectively, from both light and heavy membrane fractions. Triton X-100 was the best agent in the series yielding 7 major bands but causes a rocketing effect because of the micelles formed. Sonication of the extract will reduce micelle size and reduce rocketing.

(1) Edwards, Jesse J. and George B. Cline. Solubilized enzymes and protein patterns of bovine fetal and adult plasma membranes. 1976. (Abstract)

NEW METHODS FOR COMPARING NUTRITIVE VALUE OF PROTEINS

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Protein malnutrition is a major worldwide problem aggravated by increasing population pressures, limited arable land, and shortage of animal protein. Potential remedies include greater use of high-protein oilseed meals, improvement of cereal grains by breeding, and amino acid fortification. Selection of the most efficient remedies requires improved methods of comparing proteins over a range of intakes, as human diets vary in % protein. New methods are now made possible by the demonstration (Morgan *et al*, PNAS *72*, 4327, 1975) that animal nutritional responses obey kinetics expressed by the four-parameter equation $r = (bK_I+R_{max}K^n)/(K_I+I^n)$ in which r is observed response, I nutrient intake,

R_{max} the response asymptote at high I, n the apparent kinetic order, b the calcd. response at I=0, and K_I the nutrition const. An additional const. $K_{.5}$ is defined as the intake at half-max. response where $r=(R_{max}+b)/2$; $K_{.5}=K_I^{1/n}$. The consts. are calcd. by computer from data pairs (I,r) obtained by feeding graded nutrient levels to groups of animals over a fixed time. Protein Efficiency Ratio (PER) is r/I and may be calcd. at any intake or response level. Net Protein Utilization (NPU) is $(r-b_o)/I$, where b_o is actual prot. loss of a group on prot.-free diet. The ratio of PERs of two proteins at const. I is r_1/r_2; that of NPUs at const. I is $(r_1-b_o)/(r_2-b_o)$. At const. r the ratio of both PERs and NPUs is the inverse ratio of intakes I_2/I_1. Slope comparisons may be made at any intake or response level by use of the equation $dr/dI=[(R_{max}-b)(nK_I I^{n-1})]/(K_I+I^n)^2$.

A MATHEMATICAL MODEL FOR THE DESCRIPTION OF NUTRIENT RESPONSES

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An important goal in nutrition is the development of a mathematical model which will allow the quantitative prediction of an organism's response to a nutrient administered at a specified level. We have developed a model in this laboratory which does this. Using equation 1 and computer software also developed by us, we have been able to construct theoretical nutrient-response curves which encompass wide ranges of nutrient intake. These curves have high degrees of statistical significance.

$$r = \frac{BK_I + R_{max}I^n}{K_I + I^n} \qquad \text{(Eq. 1)}$$

where: r = observed response of the organism; R_{max} = asymptotic (limiting) response; I = nutrient intake; b = ordinate intercept; K_I = nutrition constant; and n = apparent kinetic order.

The model has been useful in describing: 1) weight gain vs. nutrient intake, 2) blood protein vs. nutrient intake, 3) amount of food consumed vs. % protein in diet and 4) time-dependent growth curve.

Using the model, one can: 1) compare nutrient sources quantitatively, 2) determine the intake level of the maximum rate of transformation of response into intake, 3) determine the intake level of highest efficiency of nutrient usage, 4) determine the maximum "profit" based on cost of nutrient and value of response, 5) study *in vivo* metabolic kinetics and 6) improve log dose-response curves.

Many other aspects of useful information may be derived from an accurate mathematical model. Having such a mathematical model allows

one to make quantitative predictions concerning nutritional responses and ultimately, to determine ratios of nutrients for the formulation of an optimal diet.

SOME CHARACTERISTICS OF ANTIGEN-ANTIBODY COMPLEX FORMATION

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Antigen-antibody interactions are traditionally treated thermodynamically as if they were adsorption phenomenons. However, this approach has several drawbacks. Examples are: 1) it does not take into consideration that complexes which contain more than one part of antibody molecules as well as antigens may be formed, 2) it cannot explain the shape of preciptin curves, and 3) it predicts that experimentally obtained association constants are independent of the concentration range of antigen and antibody used in the experiments.

To overcome these difficulties, a new mathematical model has been developed, based on a previously described computer simulation model. Two formulas have been derived to describe the relationship between the total and the free concentrations of antigen and antibody in a given system:

$$(1)\quad (Ag)K = [Ag]K + \sum_{j=1}^{j_{max}} \sum_{i=1}^{j+1} i([Ag]K)^i([Ab]K)^j$$

$$(2)\quad (Ab)K = [Ab]K + \sum_{j=1}^{j_{max}} \sum_{i=1}^{j+1} j([Ag]K)^i([Ab]K)^j$$

The mathematical method for solving these equations will be described in the following contribution. The concentration of any single antigen-antibody complex can be calculated from:

$$(3)\quad [Ag_iAb_j] = [Ag]^i\ [Ab]^j\ K^{i+j-1}$$

By assuming that the complexes which typically are formed under antibody excess conditions are insoluble, this new approach: a) can predict the characteristic shape of a precipitin curve, b) does not exclude any theoretically possible complex, and c) also accounts for the apparent concentration effect on experimentally obtained association constants.

Furthermore, comparisons between the amounts of antigen which can be bound by a given amount of antibody using the traditional approach and using the new approach have revealed that the formation of genuine antigen-antibody complexes means that less antigen is bound if complex formation is taken into consideration as part of the mechanism than if it is not. However, we suggest that the main advantage in the formation

of antigen-antibody complexes is the creation of a high degree of specificity by invoking several immune specific bondings in each antigen-antibody complex.

A NEW THEORETICAL APPROACH TO ANTIGEN-ANTIBODY INTERACTIONS

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As stated in the previous contribution by Steensgaard et al., we have developed two equations which describe the relationship between the total and free concentrations of antigen as well as antibody, when it is assumed that all mutual interactions can be described by one common association constant. This contribution deals with the mathematical solution to these equations.

The equations in question can be solved only by an iterative technique, i.e. that numerical guesses on the right solution are iteratively calculated in a steadily improved way until the right solutions are found. The Newton-Raphson technique was chosen in this case because the improved guess values can be obtained analytically.

The main difficulty in such numerical techniques is to provide good initial values for the iterations. We have found that a Langmuir adsorption isoterm for low concentrations of antigen and antibody will provide good initial values. For higher concentrations a series of imperical formulas has been developed based on analysis of calculations where the adsorption isoterm proved insufficient. The imperical formulas have been tested exhaustively and were found to provide good initial guess values over a wide range of concentrations of both antigen and antibody.

A program in BASIC has been written and will be described briefly.

Finally, predictions made by use of this model are compared to experimentally obtained analysis of antigen-antibody complex distributions made by rate-zonal centrifugation of equilibrium mixtures of antigen and antibody. A good agreement between experimentally obtained results and calculated complex distributions was found. It is concluded that the present theory yields valid predictions, and that it is valuable for further studies of the thermodynamics of antigen-antibody interactions.

THE USE OF ACRYLAMIDE GELS TO ANALYZE ZONE BROADENING IN ZONAL ROTORS

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Zonal centrifugation is a widely used technique for the isolation and purification of a wide variety of cells, subcellular particulates,

viruses, etc. Zonal centrifuge rotors which have been designed for laboratory scale separation are essentially hollow cylinders with septa inside. The volume of the B-XIV rotor is 660 ml and the volume of the B-XIV approximately 1660 ml. Although excellent separations can be performed, there are several factors which can disturb or alter separations by widening zones and reducing resolution. Some of these factors include overloading, diffusion, mixing, radial dilution, in the rotor plus laminar flow in the loading and unloading lines. We have found that by making up sucrose gradients containing acrylamide with appropriate reagents required for polymerization, it is possible to "stop the action" in the rotor during centrifugation. The rotor is disassembled and the acrylamide gel which contains the gradient and the sample, is removed for analysis. This technique, for the first time, permits, good observation of transitory events taking place during sedimentation. Preliminary results using human hemoglobin indicate that end cap drag effect on the solutions, at least over silicone-treated surfaces, has less of a zone broadening effect than expected. Studies are in progress to determine the effects of rapid sample loading and overloading zones on separation resolution.

METABOLISM OF POLY-γ-GLUTAMATES OF FOLIC ACID

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Information continues to accumulat suggesting that poly-γ-glutamyl derivatives of folic acid are the functioning coenzymes of one-carbon metabolism. Methods are now available to identify each member of the family of folate coenzymes quantitatively with respect to its total number of γ-glutamyl residues. These methods have now been applied to a variety of bacteria, to baker's yeast, and rat liver. Although the distribution of γ-glutamyl chain lengths is variable in these sources, they all contain none or traces of the pteroyl mono- and diglutamates. Recent experiments involved the determination of chain length distribution in *Escherichia coli* grown on minimal medium and harvested at 2, 4, 5, 6, and 24 hours. Results from these experiments confirm the reproducibility of the methods and, since the distribution is constant with time, indicate that the forms identified are indeed the functioning coenzyme forms. Experiments were then conducted with *E. coli* grown in minimal medium supplemented with a mixture of end products of one-carbon metabolism. Results from these experiments indicate that shifts in the chain length distribution toward longer chains at the expense of shorter ones occur under these conditions. Presently, one-carbon metabolites are being added singly in the hopes of getting data that can relate individual chain lengths to single one-carbon metabolites. For years it has been accepted that the hepta glutamyl derivative of pteroic acid is the maximum length reached in nature. Our studies with baker's yeast and *E. coli* have yielded up to 10% of the folates as the octa derivative.

EFFECT OF PYRAZOLE ON BLOOD LEVELS OF ETHYLENE GLYCOL IN MICE

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The pharmacokinetics of ethylene glycol in mouse plasma were explored before and after pyrazole administration. The results are preliminary data in a series of experiments designed to study the *in vivo* mechanisms of antidotal therapy in ethylene glycol toxicity.

Ethylene glycol (EG) and glycolaldehyde (GA) were qualitatively and quantitatively analyzed in water and plasma utilizing a Hewlett-Packard 402 Gas Chromatograph (GC) equipped with a Tenax GC column and flame ionization detector. Serial dilutions of EG and GA were compared to a fixed concentration of the interval standard, propylene glycol (PG). Peak height ratio was chosen as the criteria for quantitative determination. The recovery of ethylene glycol from plasma was excellent, whereas the recovery of glycolaldehyde was poor, the latter disappearing with time.

Female, Swiss, albino mice were injected with 2 ml/kg and 4 ml/kg EG, intraperitoneally. The decay of EG, unlike ethanol, at the two dose levels appeared to obey first order kinetics.

Two additional groups of mice were dosed with 4 ml/kg EG; one group received 300 mg/kg pyrazole intraperitoneally 15 minutes after EG dosing, whereas the other group received 600 mg/kg pyrazole subcutaneously one hour prior to EG dosing. Pyrazole was found to shift the decay curve of EG to the right. At no time was glycolaldehyde detected in these experiments.

These findings lend indirect evidence to the theory that pyrazole does inhibit alcohol dehydrogenase *in vivo* and the antidotal effect of pyrazole is due to the delay of formation of more toxic metabolites.

EFFECTS OF ASPIRIN ON PULMONARY PARAMETERS DURING HYPOVOLEMIC SHOCK

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Preliminary data obtained in this laboratory with the prostaglandin synthetase inhibitor aspirin suggest that prostaglandins may play a detrimental role in the lung in shock. These data indicate that pulmonary changes in hemorrhagic shock are considerably reduced when animals are treated with 25 mg/kg of aspirin prior to bleeding to 50 mmHg blood pressure and maintaining this pressure for 2 hours. After this time the shed blood was reinfused, and the animals monitored for an additional

two hours. Changes in cardiac output and pulmonary vascular resistance were similar in both the treated and untreated groups. However, the drop in dynamic compliance of lungs seen in the untreated animals was significantly less pronounced in the aspirin treated group (45% drop in control group, 10% in treated). Airway resistance remained fairly stable until reinfusion, at which time it fell in the treated animals, but increased in the untreated animals. Pulmonary vascular resistance initially fell, then rose above control in both groups during hemorrhage. However, after reinfusion, PVR began to decline in the treated dogs, but rose markedly in the untreated group.

These results suggest that endogenous prostaglandins released during hemorrhagic shock may have actions that are detrimental to pulmonary function and that these actions may be controllable with prostaglandin synthetase inhibitors such as aspirin.

CONCENTRATION AND METABOLISM OF THE ANTITHYROID DRUG PROPYL-2-THIOURACIL BY HUMAN POLYMORPHONUCLEAR LEUKOCYTES

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The antithyroid drug PTU, which accumulates in the thyroid, was concentrated by PMN with ^{14}C-PTU and ^{125}I uptake increasing 8-10 fold in phagocytic cells. This suggested that PMN may serve as an *in vitro* system to study the accumulation and metabolism of PTU. Studies of the relationship of iodide uptake to PTU accumulation showed that iodide above 5×10^{-3} µmoles/ml inhibited PTU accumulation slightly. Perchlorate, an inhibitor of thyroid iodide uptake, had no effect on either PTU or iodide uptake in PMN, while thiocyanate inhibited only iodide uptake. Iodide organification in PMN is catalyzed by myeloperoxidase which is inhibited by PTU, azide and cyanide. PTU accumulation increased by 600% as PTU was increased from 0.005 to 0.5 µmoles/ml although myeloperoxidase was markedly inhibited as indicated by iodide organification which decreased 70% with 0.05 µmoles/ml of PTU. Azide and cyanide increased PTU uptake by 180 and 95%, respectively, at concentrations inhibiting I^- organification 50-85%. This stimulation was accompanied by a 60-70% increase in available H_2O_2 which provided further evidence of marked myeloperoxidase inhibition. Protein-bound radioactivity accounted for 20% of the accumulated ^{14}C in resting cells and 55% in phagocytic cells. The extractable radioactivity was composed of PTU and sulfinic and sulfonic acids of PTU which were similar to the products formed by H_2O_2 oxidation of PTU *in vitro*. The results presented indicate that I^- metabolism and PTU uptake in PMN are unrelated. The association between increased PTU uptake and increased H_2O_2 accumulation and the presence of primarily oxidative metabolites in the cells suggest that PTU uptake is related to oxidation of the drug.

ISONIAZID INHIBITION OF *MYCOBACTERIUM PHLEI* CATALASE ACTIVITY: POSSIBLE MECHANISM OF ACQUIRED RESISTANCE

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The mechanism of acquired resistance to the important antitubercular drug isoniazid (INH) is unknown. A consistently observed biochemical parameter which changes upon acquisition of INH resistance is a decline in catalase activity. To determine the role of catalase in the action of INH the catalase activities of INH susceptible and resistant strains of the saprophytic mycobacterial species *Mycobacterium phlei* were compared.

M. phlei ATCC 345 was isolated which was resistant to 200 µg INH/ml. Catalase activity in osmotic lysates of the resistant strain was consistently observed to be about 40% less than that in wildtype lysates. INH concentrations between 1mM and 100mM inhibited the catalase activity in osmotic lysates of the wildtype up to 85%. No inhibitory effect of the residual activity was observed at INH concentrations as high as 0.9M. INH had no effect on the catalase activity in resistant strain osmotic lysates at all INH levels tested. Acrylamide gel electrophoresis of the lysates showed that the wildtype possessed two bands of catalase activity whereas only one band was observed in the lysates from the INH-resistant strain. The single band of catalase activity from the resistant organism corresponded with the most rapidly migrating enzyme of the wildtype. Addition of INH inhibited the appearance of only the slowest migrating band of the wildtype lysate. Hence the catalase not present in the resistant strain may represent an INH sensitive catalase isozyme necessary for the drug's action. Its subsequent loss suggest a possible mechanism for INH resistance.

MOUSE LIVER MACROPHAGES AND LIPOPOLYSACCHARIDE NEUTRALIZATION

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Mammalian immune systems can respond to immunologic affectors by humoral mechanisms, cellular mechanisms or a combination of the two. Cellular mechanisms, especially involving macrophages, seem to play a major role in phagocytosis and subsequent digestion of many forms of particulate matter. One postulated role has been Kuppfer cell neutralization of endotoxin by phagocytosis and subsequent lysosomal digestion. Three experiments were performed to elucidate this neutralization process. Three groups of mice were immunologically stimulated with Venezuelan Equine Encephalitis Virus (a non-specific stimulator of cell

mediated and humoral immunity) at three different time intervals. Non VEE infected mice served as controls. One group was sacrificed and perfused, then their livers removed and the RES cells isolated. A second group was sacrificed and perfused with the product used to construct a crude homogenate. A third group was not perfused after sacrifice but the livers were homogenized with the circulating blood elements still in the sinusoids. The three resulting products, purified macrophages, macrophages plus parenchymal cells and macrophages plus parenchymal cells plus blood were compared for their respective lipopolysaccharide neutralization properties by two parameters. Acid phosphatase activity was used as an indicator of lysosomal activity while a mouse bioassay was employed to determine the extent of inactivation. Preliminary data indicates that macrophages alone are not solely responsible for lipopolysaccharide neutralization but rather are dependent on yet unidentified serum components.

THE ACTION OF IMIDAZOLE ON THE IN VITRO FROG GASTRIC MUCOSA

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Alonso, et al., AJP 208:1183 report that imidazole and related compounds added to the solution bathing the nutrient side of the secreting frog gastric mucosa markedly reduce the H^+ rate. Much evidence indicates that weak bases rapidly diffuse across the gastric mucosa in their neutral form and hence it is possible that these compounds do not inhibit H^+ secretion but simply neutralize the H^+. The charged (protonated) form of imidazole, produced by neutralization of H^+, is then trapped in the mucosal fluid. With this fluid maintained at a pH of 4.5 practically all of the imidazole would remain in the charged form and acid would not be titrated (pKa = 7.0). If imidazole simply neutralizes the H^+ ions then the amount of imidazole diffusing across and entering the mucosal fluid should equal the measured decrease in H^+ rate, assuming the rate of H^+ does not change. The rate at which imidazole moves across the gastric mucosa was measured with C^{14} labeled imidazole and it was found that the decrease in the measured H^+ rate equaled the rate of movement of imidazole across the mucosa. The ratio of the change in acid rate to the rate of imidazole movement was 1.08 ± 0.19 (4 experiments). It was further shown with the pH of the secretory fluid fixed at 8.0 that imidazole produced no substantial reduction in the measured H^+ rate. This would be expected since 90% of the imidazole which is protonated in the lumina would yield H^+ at pH = 8.0 and be titrated. Therefore imidazole does not inhibit H^+secretion but neutralizes the H^+ already secreted.

THE ROLE OF BUTYRATE AND/OR LIPOATE ON THE IN VITRO FROG GASTRIC MUCOSA

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Using the in vitro *Rana pipiens* gastric mucosa, 5 mM butyrate added to nutrient solution (at pH 7.4) stimulated the acid secretion rate; in addition, butyrate decreased the transmucosal electrical potential difference and decreased the electrical resistance across the tissue. The stimulation could be inhibited or blocked, depending on the sequence of the experiment, by burimamide (10 mM) or Mn^{++} (10 mM); in contrast, the stimulation observed following DBCAmp could not be blocked by these compounds. The mucosa did not show tachyphylaxis effects with second, third, or fourth additions of butyrate as it did for pentagastrin (P.G.) or histamine. Previously in experiments using bullfrog stomachs, lipoate was shown to convert the gastric mucosa from a fatty acid utilizing to a carbohydrate utilizing tissue (Harris, et al., AJP 228:964, 1975). However our results differ from those obtained when the bullfrog gastric mucosa was used. Using *Rana pipiens*, lipoate (1 to 10 mM) inhibited the acid secretion rate stimulated by either P.G. or histamine, and the addition of compounds that could serve as substrate (i.e., glucose, acety CO-A, etc.) did not reverse the lipoate inhibition. Butyrate (10 mM) stimulated an acid secretion rate after inhibition by lipoate (1 mM), but the rate was not restored to controlled levels.

ENGINEERING

NONLINEAR RESONANCE IN DUAL-SPIN SPACECRAFT DUE TO MASS ASYMMETRIES

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The phenomenon of nonlinear resonance in the attitude motions of a dual-spin spacecraft which is composed of a slightly asymmetric, rigid rotor and a symmetric, rigid platform that does not have its axis of symmetry aligned with a principal axis of the rotor is studied. The equations which govern the rotational motion of the system and the relative motion of the platform with respect to the rotor are derived in an unconventional form, since the dependent variables are rotor-fixed components of the angular momentum of the system about its center of mass, the momentum conjugate to the angle of relative rotation of the platform and that angle of relative rotation. Equations which are in the normal form for applying the Method of Averaging are derived by treating terms due to the assymetries of the rotor and the platform as perturbing terms. The condition for nonlinear resonance is determined and motion near resonance is discussed.

SIMULATION MODELS FOR LASER GUIDED MISSILES

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As part of an exploratory development program, an analysis effort was designed to identify potential problems in the mechanization of a new weapon system concept. One of the first steps was to develop a full six-degree-of-freedom (6-DOF) digital simulation for evaluation of various autopilot hardware configurations that would enable selection of a guidance system mechanization. To meet the criteria established, the guidance law was developed from those candidates that used only angle or angle rate information to the target. The techniques considered included attitude pursuit, velocity pursuit, and proportional navigation and guidance (PNG). The more recent simulation activity -- after hardware development had begun -- has been directed toward optimizing the PNG guidance law and autopilot mechanization. This took the form of changes and modifications to almost every major component including the navigation ratio, network time constants, damping mechanizations, gyro, seeker, aerodynamics, and control actuators. As initial design components were made available, they were evaluated and the test results were modeled for introduction into the simulation. The evolution from models of ideal components through models representing hardware test data is presented within the framework of increasing the validity of the all-digital simulation as a predictor of system performance.

SOLAR ENERGY AVAILABLE IN ALABAMA

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An ever increasing cost and decreasing supply of natural fuels has prompted significant interest in solar energy. Heating of water and of buildings provide the simplest first step in the use of direct energy from the sun. Not all areas of the country or of the world are equally blessed with this energy. A consideration of Alabama's share of the newly appreciated natural resource is made in view of seasonal and diurnal effects of sun direction, percentage of sunshine, and duration of sunshine. These factors, along with possible tracking and non-tracking solar collector configurations, and normal heating load requirements, provide a basis for determining the practicability of Alabamians using solar energy.

MODELING OF TARGET ECHO DECORRELATION IN A FREQUENCY SCANNED RADAR SYSTEM

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A computer-simulated radar target model is introduced to examine the decorrelation of target echoes as a function of the beam-steering frequency increment in a frequency scanned array radar. The effects of target echo decorrelation are to degrade the performance of track-while-scan radars which require a constant radar cross-section during the scan period for highest accuracy. Of special interest in this study are radars for aircraft automatic landing systems. These systems experience another source of target echo decorrelation due to the rapidly changing aspect angle of landing aircraft. These sources of target echo decorrelation are two of the many factors which must be considered in the trade-offs of radar design.

ADAPTIVE ARRAYS: IMPROVED ANTENNA PERFORMANCE THROUGH SIGNAL PROCESSING

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An adaptive clutter decorrelation technique is employed in a phased array antenna to improve the signal-to-noise ratio. The direction of arrival of a coherent clutter signal (jammer) is automatically sensed, and a retordirective antenna beam is generated in real time which is directed toward the undesired noise source. The gain of the adaptively formed pattern in the direction of the jammer is the negative of the pattern of the normal array, so the resulting gain of the antenna in the direction of the jammer is reduced. Consequently, less total noise power is introduced into the array output. However, the gain of the array in the direction of the desired signal is also slightly reduced. The technique is designed, however, to generate the optimum set of array weights: that is, those weights which maximize the ratio of signal power to total noise power (signal-to-noise ratio).

The theory supporting this technique is described for the case of a linear array. If a plane wave is incident from the θ direction on a linear array, the complex element voltages, v_i, will be proportional to $e^{j(2\pi/\lambda)id\cos(\theta)}$, where λ = wavelength, θ = angle of arrival, and d = element spacing. It is a well known fact in signal detection theory that if all noise in a system is uncorrelated, then the optimal element weights

to receive v_i will be proportional to v_i^*, where * denotes conjugation. If coherent noise is introduced, the weights, v_i, will not be optimal. The philosophy, then, is to decorrelate, by an appropriate filtering technique, all coherent noise. With all noise thus decorrelated, the appropriate weights to maximize the signal-to-noise ratio are picked according to the criteria for uncorrelated noise.

ELECTROMAGNETIC MECHANISMS IN BIRD ORIENTATION AND HOMING

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Considerable evidence is mounting to support the theory that bird orientation and homing is a multi-sensory activity which includes sensitivity to the Earth's magnetic field. Thus, the migrating or homing bird makes use of as many orientational cues as possible and integrates their meanings to navigate. A primary orientation aid in unfamiliar areas is the position of the Sun. However, homing pigeons and migratory birds are able to navigate even when the Sun is totally obscured by clouds. Experiments indicate that in overcast conditions homing pigeons can be made to orient to magnetic fields produced by the sum of the Earth's field and that of a magnetic coil placed around the bird's neck. This orientation is the response of an, as yet undiscovered, sensory system. Possible electromagnetic mechanisms in this sensory system include induced electromotive forces and torques on magnetic dipole sensors.

AN APPLICATION OF HARDWARE-IN-THE-LOOP SIMULATION METHODS

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Hardware-in-the-loop simulation in a valid technique for testing advanced concepts and designs of missile systems. This technique is more accurate than an all-digital simulation, since flight hardware is a part of the simulation. In addition, the technique is more economical, and in some aspects more versatile, than actual flight tests.

The Radio Frequency Simulation System of the U.S. Army's Advanced Simulation Center, Redstone Arsenal, Alabama, facilitates hardware-in-the-loop simulation of missiles. The hardware components that can be included in the simulation are: (1) the seeker head, (2) the autopilot (with gyros), and (3) the control surfaces. The missile target is simulated through the use of an antenna array. The remainder of the missile system (missile translation, aerodynamic moments, etc.) is simulated using hybrid computers.

An anti-radiation missile is a missile designed to attack radiating targets, principally radars. The Radio Frequency Simulation System is nicely suited for the hardware-in-the-loop simulation of anti-radiation missiles. This paper presents the results of an investigation into the problems of implementing a hardware-in-the-loop simulation of anti-radiation missiles. A primary purpose of the investigation was the development of the most convenient form for partitioning the hybrid portion of the simulation and the determination of interface requirements for the simulation. In addition, problems that arise with the various coordinate systems required for the simulation were studied. This paper discusses solutions to these problems.

SOLAR HEATING AND COOLING SYSTEMS ANALYSIS AT MSFC

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The goal of the Solar Heating and Cooling (SH&C) Systems Analysis task at MSFC is to develop a systematic procedure to support the decision-making process for determining the most cost-effective development and demonstration program for the application of solar heating and cooling systems. While refinements are still being made, an operational systems analysis procedure and related software are now being utilized in the evaluation of proposed SH&C systems/sub-systems and potential application sites. The overall procedure includes climatic analysis, building/application analysis, loads analysis, conventional heating and cooling systems synthesis, solar heating and cooling system synthesis, simulation of system operation, cost analysis, capture analysis, economic analysis, and benefit analysis. Each of these areas will be discussed in the paper and examples of utilizing the overall procedure will be presented.

COMPUTER SIMULATION OF A MULTIFUNCTIONAL RADAR

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This paper describes a computer simulation applicable to a multi-functional radar. The typical radar mission simulated in tracking a low angle, short range target closing on the radar site, while simulated is tracking a low angle, short range target closing on the radar site, while simultaneously maintaining a sector search. Allocation of radar parameters for multi-functional use is discussed.

AGGLOMERATION OF IRON ORE

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Experiments have been conducted to find an organic substitute for bentonite as a binder in pelletizing iron ore. Several organic compounds have been used as binders to make pellets in the laboratory. Various tests have been performed to compare these pellets containing organic compounds with pellets containing bentonite.

Among the tests that have been performed are the eighteen inch green drop test, green compressive strength test, dry compressive strength test, dry compressive strength test, and fired compressive strength test. It was found that the organic additives produced pellets which compared well with pellets containing bentonite in all four of these tests.

Several other tests involving the organic binders have been performed or are being planned. A core gas determinator has been used to determine the burning point of each organic binder and the amount of gas evolved per gram of organic binder in a N_2 atmosphere. Additionally, the microstructures of the pellets and the strength of the pellets at intermediate temperatures have been examined. Before the research is concluded, the chiba reducibility test will be performed to compare the reducibility indexes of the pellets made with organic binders to pellets made using bentonite.

MINIMIZATION OF ENVIRONMENTAL EFFECTS FROM UNDERGROUND COAL MINING

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The University of Alabama, in a contract with the Environmental Protection Agency, has undertaken a study of the undesirable effects of underground coal mining with the object of identifying factors in site selection, mine lay-out, mining method, and mine closure that will minimize pollution during the life of the mine and after it is abandoned.

Three sites were investigated in Bibb, Walker and Fayette-Tuscaloosa counties. The Bibb and Walker county sites lay in former mining districts while the Fayette-Tuscaloosa site is a new mine in a new district. Of the three most common environmental effects, air pollution, water pollution, and surface subsidence, the first was not a problem because of the rural setting of all 3 sites and no observations or experiment work was possible on mine subsidence at any of the sites.

Water pollution from former mining at the first two sites, or from an operating mine at the third, was found not to be serious. Few samples had a pH in the acid range and heavy ions were not numerous.

Conclusions were: (1) drift mines driven up dip are the worst case for acid mine drainage. (2) Deep mines, far from the outcrop, give minimal pollution and, if sealed, should yield little pollution after abandonment. (3) Removal of all the coal will result in some subsidence of the entire area but with minimal or no differential subsidence. (4) If no differential subsidence is permissable, as under a city, adequate support pillars should be left everywhere. (5) Drift mines, if driven down dip, can pump all water to one point where it will be easy to treat. (6) A caving method, like longwall, where it can be used, may yield less mine drainage than room-and-pillar, with secondary pillar removal.

QUALITY OF WATER STORED IN SOME ABANDONED UNDERGROUND MINES, CAHABA COALFIELD, ALABAMA

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In spite of all the noise made in recent years over water pollution and acid mine drainage, apparently no investigations have been made and nothing published on the quality of water stored in, or flowing out of, abandoned underground coalmines in Alabama.

As part of a research contract with the Environmental Protection Agency, The University of Alabama determined the water quality at three potential sites for new coalmines. One of the sites, in the Cahaba Coalfield, is in the Cahaba River drainage, downstream from areas extensively mined underground in the past and still being mined by surface methods. The two sampled underground mines are close to the proposed mining site.

The water in the Cahaba River, Pratt Creek and even that taken from Hargrove No. 1 and No. 2 slopes was not badly polluted. One of 12 samples was in the acid range, having a pH of 6.2. Heavy metal ion concentrations were quite low. Inorganic pollution was higher, generally, for the samples collected during wet weather, probably due to flushing. Areas receiving strip pit overflow in rainy weather had a higher pH. The Cahaba River, where it flows out of the coalfield, was as pure as expected of a normal river in almost any environment.

ANTHROPOLOGY

ACADEMIC ACHIEVEMENT, IQ, LEVEL OF OCCUPATIONAL PLANS, AND SELF-CONCEPTS FOR ANGLO AND NAVAHO HIGH SCHOOL STUDENTS

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Differences in academic achievement, IQ, level of occupational plans, and concepts of the actual or present self, ideal self and self in five

years and the interrelations among these variables within each ethnic group were investigated. The subjects were 54 Anglo and 57 Navaho males in the senior class of a multi-ethnic high school. Grade point average, the California Achievement Test, the California Test of Mental Maturity, the Warner, Meeker, Ells's Revised Scale For Rating Occupation, and the semantic differential technique were used to measure the above variables. Various hypotheses were tested and most received at least some support. The .05 level of significance was adopted.

The Anglos surpassed the Navahos in academic achievement, IQ, and level of occupational plans; and all of these variables were positively associated with each other within each ethnic group. Most of these differences and associations were significant. In comparison with the Navahos, the Anglos had, generally speaking, slightly higher concepts of the present self, higher concepts of the ideal self, and similar concepts of the self in five years. The most significant differences were found for concepts of the ideal self. The various self-concepts were positively intercorrelated within each ethnic group, and most of these correlations were significant. With one exception, none of the correlations between academic achievement, IQ, and level of occupational plans and the different self-concepts were significant; but most of these relationships were positive for the Navahos. Cultural differences and disadvantages were used to explain the above findings.

MORE ABORIGINAL STONE STRUCTURES IN CALHOUN COUNTY

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The author has previously reported on stone structures of unknown origin on the crest of Morgan Mountain in Calhoun County[1], similar to those on mountaintops throughout the Southeast.[2] Two additional structures, previously unrecorded, have been found on mountaintops near Choccolocco Creek, and reconnoitered by helicopter[3] and on foot.

One structure, covering an area approximately 24 x 18 m is situated on a small mountain near Boiling Springs, and contains a number of depressions, a common characteristic. The stone doesn't seem to be dressed, but gives evidence in some places of fitting, rather than being simply piled up.

The second location is on Brock Mountain and is much more modest in scale, consisting of a single "enclosure". An aviation beacon light is nearby, and it is possible that its construction eradicated a portion of the earlier structure. A low stone wall at this site is thought to be of more modern origin.

[1]Reid, W. J., "Aboriginal Stone Constructions on Morgan Mountain in Calhoun County", Alabama Academy of Science, April, 1975.

[2]Smith, Phillip E., "Aboriginal Stone Constructions in the Southern Piedmont", University of Georgia, Laboratory of Archaeology Series, Report No. 4, Athens, Georgia (1962). pp. 1-47.

[3]Helicopter flight courtesy of Jacksonville State University Department of Military Science.

WHITHER THE NEW ARCHEOLOGY

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The concept of processual archeology, which embodies novel and sophisticated data analysis, is itself being tested. Having incorporated certain techniques based upon a research design or planning format which emphasizes the testing of hypothesis derived from previous investigation, the system, known popularly as "the new archeology" may be facing an uncertain future.

The shift to needs dictated by a growing need for site surveys and subsequent salvage of threatened resources imply a return to rapid field recovery on a deadline basis. Such an approach is not compatable with procedures typical of the new archeology, and appears as a sharp departture from the painstaking and time consuming techniques seen in the newer method. Yet, as the technological demands of our exploding urban civilization accelerate--the threat to this new evaluation procedure is clearly evident.

THE ARCHAEOLOGY OF THE GAINESVILLE RESEVOIR

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Four summers of archaeological investigations within the proposed Gainesville Reservoir of the Central Tombigbee River have yielded the necessary information for a regional chronology and an outline of each of the cultural systems which existed through time. This paper discusses the 10,000 year prehistory of the reservoir area. In doing so, each phase is discussed as a cultural system, and how each system interacted with and was adapted to its environment. In this manner the progressively effective adaptive strategies are traced through time.

INTERSTATE-65 ARCHAEOLOGICAL SALVAGE INVESTIGATIONS IN JEFFERSON COUNTY, ALABAMA

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Recent salvage excavations performed by the University of Alabama, Department of Anthropology in cooperation with the Alabama Highway Department have proven to be rewarding archaeologically. Three sites were excavated and cultural remains dating to the eight millenium B.C. or earlier were recovered. Almost all of the cultural stages currently recognized in Southeastern prehistory are represented in the artifact sample.

Several interesting features were discovered which represent unique pieces of archaeological data concerning the secular and ceremonial life of peoples living around A.D. 1000 in the area. In addition, the discovery of a distinct pottery type on the one site, which had been traded to the inhabitants around 100 B.C. - A.D. 100, shows a generalized participation by that group in the Hopewellian sphere of interaction.

At one of the rock shelters investigated, the Dalton, Kirk, LeCroy and Morrow Mountain horizons were all represented in deep cultural deposits. In view of the faunal remains recovered in hearths at the shelter, the dependence upon a diversified forest-riverine environment by the Archaic groups is supported. The nature of the lithic debitage and tool forms indicate that the shelter was utilized as a limited activity station for rather short intervals of time. Activities which occurred on the site include raw material procurement, artifact manufacture and replenishing, and processing animals taken in the hunt.

BUTTONS AS AN AID FOR DATING HISTORIC ARCHAEOLOGICAL SITES

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The value of buttons as an aid for dating historic archaeological sites through identification and analysis is the primary purpose of this paper. A total of nine shank types were used as examples of shank development. The shank types discussed in this paper include the crossed wire shank, drilled wedge shank, bent wire shank, Omega shank, crossed wire cord, iron shank, and integrally cast pewter shank.

After 1768, most nations changed from a plain faced type of button to regimentally marked buttons. With this change we are able to pinpoint button manufacture and usage within a very limited expanse of time; the year 1768 is a milestone date for the study of buttons.

THE ANALYSIS OF A SKELETAL SAMPLE FROM 1PE1

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Near the community of Heiberger, Alabama, a small site designated 1PE1 revealed an ossuary pit which contained a minimum of six individuals. After reconstructing a fragmented calvarium, differential coloration and preservation were noted, leading the investigator to conclude that the bones were broken at or before interment. The calvarium also exhibited intentional fronto-occipital cranial deformation which produced a hyperbrachycranic cranial index. Careful observation of the skeletal material resulted in the identification of three males and three females in two age groups, with an average estimated stature of five feet five and three-fourth inches. Few anomalies and no pathologies other than caries were displayed. Cultural evidence presented by the skeletal material affiliates 1PE1 with the early Choctaw.

CLASSIFICATION OF AMERICAN INDIAN CRANIA: 1800-1866

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Four themes appear in the literature of North American physical anthropology during an easily recognizable period of the early 19th century. These are the Moundbuilder myth, a political debate between Europeans and Americans, linguistic studies, and the proliferation of cranial criteria. These themes and their consequences constituted the foundation of physical anthropology as a scientific discipline in the United States.

IDEOLOGY AND ARCHEOLOGY IN CHINA

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In 1974 and 1975 thousands of Americans viewed "The Exhibition of Archelogical Finds of the Peoples Republic of China." Most were duly impressed by the fossils of Lan-t'ien Man (600,000 B.C.), the fabulous jade funerary suits of Prince Liu Sheng and Princess Tou Wan, and the beautiful bronze "Flying Horse."

Few Americans who viewed the exhibition were aware of the political nature of Chinese archeology. In China archeology is "political;" a revolutionary enterprise.

This discussion deals with the increased politicalization of archeology during The Great Proletarian Cultural Revolution and the present ideological role assigned to Chinese archeology by China's revolutionary government.

The major conclusions reached are that archeology in China is enjoined to contribute to the development of a "peoples' history." Emphasis is to be placed on past contributions of the masses and their exploitation by the imperial elites. Archeology is to provide data for "popular education in ideology politics and class struggle."

THE DIRECTION OF ARCHAEOLOGICAL INVESTIGATION IN ALABAMA

Marjorie W. Gay
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The archaeologist must work carefully, painstakingly and hence slowly. But today's fast moving and changing pace has influenced his techniques and also his goals. The Southeast and our own Alabama area, with a wealth of information still protected by the soil, are of prime importance to the understanding of the cultural periods of our area and of our area's relationships within the hemisphere. Alabama has had a long and active program of archaeological investigation. Even so, our hindsight shows that some important areas of the state have been neglected. We must realize that tomorrow will be too late to formulate a statewide plan of cooperative action. Time is running out! Suddenly time has run out for the archaeologist! He must decide now whether to strive for the plan which is best for our entire state or whether to blindly follow in the direction of the pre-determined plan and the model techniques which assure everyone of the "correct answers" though often with questionable documentation.

PROBLEMS IN THE FIELD COLLECTION OF BASIC VOCABULARY LISTS: SOME EXAMPLES FROM NORTHWEST BORNEO

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Some of the important uses of vocabulary studies to anthropologists and linguists are briefly mentioned. The basic vocabulary list, a main tool of lexicostatistical study, and the principles on which it is based, is discussed. A number of problems encountered during the collection of basic vocabulary lists for languages in Northwest Borneo are examined. A number of tentative recommendations are suggested for consideration in collecting future basic vocabulary lists.

DIFFERENTIAL DIAGNOSIS AND PALEOPATHOLOGY WITH AN EXAMPLE FROM SITE 1JA376

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Burial six from site 1Ja376 exhibits an example of acute hematogenous osteomyelitis. This form of osteomyelitis resembles several of the diseases which are characterized by a diffuse osteitis, such as syphilis. This similarity of effects on the skeleton is a major problem in paleopathology, where the identification of syphilis in archeological remains is often of considerable interest. The preferable method of identifying pathologies in archeological skeletal remains is differential diagnosis. This procedure is basically one of comparison and elimination. Differential diagnosis can be divided into two major stages; preliminary observations, which consists of four steps and the actual diagnostic process which is divided into three steps. This method is applied to burial six in order to demonstrate the technique as well as identify the pathology.

A WORKING PAPER: CULTURE AND POVERTY IN APPALACHIA

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The state of flux in the Southern Appalachian region over the past twenty years has caused both visible and invisible changes to occur in the lives of the resident population. This paper is an attempt to review numerous theoretical and empirical writings on the area, relevant to a discussion dealing with the feasability of the development of a "culture of poverty." Each of Lewis' eight criteria for a "culture of poverty" is reviewed in relationship to the changes taking place within the Southern Appalachian region. The evidence indicates that a form of "culture of poverty" has developed where it had not existed at a prior time.

PHYSICS AND MATHEMATICS
(These abstracts were submitted after deadline, and are therefore out-of-order)

LASER LIGHT DIFFRACTION FROM GRATINGS AND THE EFFECT OF POLARIZATION

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Gratings became a very useful component in experimental work with lasers. Gratings are very useful as beamsplitters and polarizers. In the studies of diffuse reflection from rough surfaces, for which a rigorous theoretical solution is not available, the need to know the efficiency of a grating represents a good example in unsolved theoretical and experimental problems.

Gratings are very expensive. Therefore, the experimental work was restricted to gratings commonly used in spectrometers. Plots are presented which show for a given ratio of wavelength and groove spacing the direction in which the different orders of the spectrum are diffracted when the grating is rotated from 0^{o} to $\pm 90^{o}$ with respect to the laser beam. Blazing of these gratings has no effect on the direction of the diffracted beams which are still symmetric when in autocollimation (in the so called Littrow configuration.) However the diffracted power is not symmetric.

Measurements were performed with laser light of $\lambda = 0.6328$ μ m and gratings with 180 and 600 lines/mm; and experimental data will be presented for polarization azimuths from 0^{o} to 90^{o}. It can be observed that the intensities of spectral order beams which disappear when they approach the diffraction angles $\pm 90^{o}$ "pump" their energy gradually into well observed orders. The total efficiency which is the sum of power in all the diffracted beams has the tendency to increase with increasing angle of incidence. This is also true in the case of specular reflection.

The theory of gratings is still not rigorous, and several approximations are used for the calculation of grating efficiencies. These studies may support both, the better understanding of diffuse reflecting surfaces, and also would permit a comparison of calculating theoretical predictions with results obtained in experimental work.

A NUMERICAL MODEL FOR COMPUTING LIQUID WATER CONTENT IN FOG

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A model has been developed to compute the liquid water content of fog from standard meteorological observations. The model uses regular hourly surface data and daily upper air data. The magnitude of the exchange coefficient is a function of the wind speed at one kilometer, but the form of the vertical variation is assumed invariant. An iterative procedure is then used to compute a vertical distribution of water vapor which is consistent with the boundary conditions at the surface and at one kilometer. The difference between magnitudes of vapor at different times gives the condensed liquid water. Finally, liquid water is allowed to diffuse in the vertical in a manner consistent with the exchange coefficient.

Computed values of liquid water content near the surface are consistent with observed visibilities, and the model gives reasonable values through the lowest kilometer of the atmosphere.

ANALYSIS OF EIGENVECTORS FOR THE WIND PROFILE

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Redstone Arsenal, Alabama 35809

Simple criteria of exceedance are sought for the evaluation of wind influence upon rocket trajectories. In contrast, space and time variability of meteorological elements such as the wind lead to multivariate distribution systems. Although statistical methods in multivariate analysis have been developed to treat these systems, results based on this concept are difficult to interpret or require a specific definition for the probability of exceedance. Thus, standard statistical methodology is inadequate for practical purposes where a reduction to a one-variate system is needed. This goal is not always trivial.

The third generation computer system developed in recent times has now made it practical to calculate empirical polynomials or eigenvectors (in mathematical terminology) at a reasonable cost even for large data collectives. Consequently, the first eigenvector could serve as the basis of a univariate system if sufficient approximation is obtained.

The author has developed a system of eigenvectors for the covariance matrix of the wind speed profile for various altitude ranges. The first eigenvector comprises more than 90% of the data dispersion in most cases and is well suited as a characteristic of wind profile

representation. It is illustrated, however, that for the surface to 25 km altitude range the eigenvector closely resembles a Fourier term. For the surface to 10 km system a linear progression can be observed. It is therefore suitable for certain altitude ranges to utilize standard functions as the basis of a reduced univariate system, a course which had been pursued in the past. The expression by eigenvectors makes it possible, however, to develop a simple concept with univariate characteristics for altitude ranges where the problem solution has eluded us in the past.

MINUTES
ANNUAL BUSINESS MEETING
University of South Alabama
Mobile, Alabama
April 10, 1976

After Dr. George F. Crozier's scientific lecture on Marine Environmental Science, the meeting was called to order by President Denton. A motion was made by Dr. Barker and seconded by Dr. Carmichael that the minutes be adopted. Motion carried.

REPORT OF THE SECRETARY (Danice H. Costes):

I.	Biological Sciences	125 Members
II.	Chemistry	50
III.	Geology	38
IV.	Forestry, Geography & Conservation	17
V.	Physics & Mathematics	75
VI.	Industry & Economics	38
VII.	Science Education	38
VIII.	Social Sciences	37
IX.	Medical Sciences	49
X.	Engineering	48
XI.	Anthropology	23
Members - No Sections (No Sec. Code)		120
Total Members		658
New Members		73

REPORT OF THE TREASURER
(Hoyt Kaylor): Jan. 1, 1975 - Oct. 9, 1975

RECEIPTS	ACTUAL	ESTIMATED
Membership Dues	$ 4,324.00	$ 5,200.00
Annual Meeting	814.05	1,200.00
Research Grants		200.00
Journal Subscriptions and Sales		200.00
Industry Contributions to AJAS Humanities Symposium	1,300.00	2,200.00
Total Net Receipts for the Period	6,438.05	9,000.00
First National Bank of Birmingham Certificate of Deposit (Closeout)	7,500.00	
Total Receipts	$13,938.05	

EXPENDITURES	ACTUAL	BUDGET
Publication of Journal (Seven quarterly Issues)		$ 8,900.00
Printing (Two quarterlies: Vol. 45, #3 and #4)	$ 3,000.00	
Typing of Journal Copy	710.74	560.00
Honoraria for Editor	200.00	700.00
Student Awards	35.00	165.00
Research Grants	515.00	400.00
Assistance to AJAS		
Support (for high school research grants)	150.00	250.00
Industry Contributions to Humanities Symposium	1,325.00	2,000.00
Annual Meeting		
Expenses Net		250.00
Programs	468.30	650.00
Academy of Science Award (Outstanding Teacher)	100.00	150.00
Speakers, Officers' Expenses, etc.		200.00
Academy of Science Assessment	41.75	40.00
Operating Expenses		
Office of the President	125.00	125.00
Office of the Secretary	77.96	650.00
Office of the Treasurer	152.36	300.00
Office of Editor of the Newsletter		50.00
Office of Coordinator of Science Fairs (Regular Fund)	150.00	150.00
Office of Coordinator of Science Fairs (Emergency Fund--1975 only)		750.00
Public Relations Committee		100.00
Supplies	61.95	200.00
Newsletter	45.00	400.00
Chairman, Membership Committee	40.00	150.00
Vice-Presidents (11 x $20.00)		220.00
Expenditures To Date	$ 7,198.06	$17,660.00

Balance in Checking Account 12-31-74	3,174.99
Total Receipts	13,938.05
Total Expenditures to Date	- 7,198.06
Balance in Checking Account 10-9-75	$ 8,414.98

Jefferson Federal Savings and Loan Association, Birmingham, Alabama, Savings Certificate
Value 12-31-74 (To be closed out on Anniversary Date) $4,541.61
(10-10-75)

(William J. Wingo): Oct. 10, 1975 - Jan. 1, 1976

RECEIPTS

From H. L. Kaylor	$ 9,914.98
From Jefferson Federal	4,747.32
Total Oct. 10	$14,662.30

EXPENDITURES

6½% Certificate of Deposit	$ 7,500.00
Passbook Savings Account	4,000.00
Checking Account	3,162.30
Total	$14,662.30

EXPENSES OCT.-DEC., 1975

Secretarial	$ 35.81
Newsletter	55.80
A.U. Department of Geology (Typing, etc.)	318.24
A.U. Honorarium	100.00
Disbursements	$509.85

Balance in Checking Account Jan. 1, 1976 $2,652.45

1976 Deposits	$4,498.00	
1976 Expenditures	802.04	
	$6,348.41	Balance in checking account April 1, 1976

REPORT OF THE AUDITOR (P. C. Bailey and D. C. Holliman)

"This is to certify that the records of the Alabama Academy of Science have been examined and have been found to be in good order as of April 7, 1976."

REPORT OF THE COMMITTEE ON PLACE OF MEETING
(Kenneth E. Landers, Chairman)

The 1977 meeting (April 7, 8, and 9) is firm for the University of Alabama in Tuscaloosa, according to Dean Moser (confirmed by telephone 2/27/76). The original confirmation was by letter from Dr. Joab Thomas who is no longer at University of Alabama in Tuscaloosa.

Dr. Ralph W. Adams, President of Troy State University, has extended an invitation to the Alabama Academy of Science and the Alabama Junior Academy of Science to meet at the Montgomery campus in 1978. A large hotel and theater is available for the meeting.

The University of North Alabama would like to host the 1979 meeting in Florence.

REPORT OF THE RESOLUTIONS COMMITTEE
(Hoyt M. Kaylor, Chairman)

"WHEREAS the Alabama Academy of Science has held its 1976 annual meeting at The University of South Alabama, and has enjoyed the hospitality of the University, now therefore,

BE IT RESOLVED that the Academy express its gratitude to Dr. Frederick P. Whiddon, President of the University, Dr. Howard M. Phillips, Vice-President for Academic Affairs, and to the University for hosting this meeting. To Dr. Eugene Wilson, Chairman of our local hosts, and to the members of his host committee, Dr. Michel LeLong, Mr. Glenn Sebastian, Dr. William Huff, Dr. George Lamb, and Mrs. Betty Guild; to the Faculty and Staff of The University of South Alabama; and to all of the many others who contributed much to the success of this meeting, we the Academy members express our appreciation for their efforts in our behalf.

BE IT FURTHER RESOLVED that the Academy express its appreciation to those who retire from leadership this year, and especially to Dr. Thomas E. Denton, President, and to Dr. Danice Costes, Secretary.

BE IT FURTHER RESOLVED that the Academy express its appreciation to Dr. Everett Smith and to Dr. George F. Crozier for their presentations to the Academy.

BE IT RESOLVED that the Alabama Academy of Science recognize and commend Mr. John L. Cain, Director of the Office of Legislative Technical Assistance Program, who, during his leadership in the State of Alabama in originating means whereby scientists and technologists could be of valuable service in the State's legislative process, has assisted the Alabama Academy in its endeavor to learn how it may better serve state government in areas of science and state policy.

WHEREAS the Alabama Academy of Science has lost one of its most distinguished members and a past president through the death of Dr. Fred Allison, and

WHEREAS Dr. Allison made many notable contributions in the field of physics and has added to the stature of science in Alabama, the South, and the nation, both as a researcher and an educator, and

WHEREAS Dr. Allison was president of the Academy in 1920-30 when the first meeting to be held on a college campus occurred, now therefore

BE IT RESOLVED that the Academy extend its sympathy to the family of Dr. Allison.

BE IT FURTHER RESOLVED that an appropriate letter together with a copy of this resolution be sent by the Secretary of the Academy to the family of Dr. Allison.

WHEREAS during the past year the Alabama Academy of Science has lost one of its prominent members through the death of Dr. Lillian Manley, and

WHEREAS, in addition to her role in the Academy, Dr. Manley had been active in the Alabama Junior Academy of Science, now therefore

BE IT RESOLVED that the Alabama Academy of Science and the Alabama Junior Academy of Science jointly extend their sympathy to the family of Dr. Manley.

BE IT FURTHER RESOLVED that the Secretary of the Academy transmit an appropriate letter together with a copy of this resolution to the family of Dr. Manley.

It is hereby moved by the Committee on Resolutions that the above be accepted and entered in the Minutes of the Academy. Resolution seconded by Dr. Barker. Resolution carried.

REPORT OF THE RESEARCH COMMITTEE
(Bernis O. Hannah, Chairman)

The Academy each year sponsors, in addition to providing research grants for qualified students, a paper competition for undergraduate students with a first place, second place and third in each position. This year there were nine requests or proposals for research grants and three papers entered for the competition.

All three undergraduate competition papers this year were in the biological sciences. The chairman of the Research Committee in conjunction with several senior investigators in the area of biology, evaluated these three entrants on the basis of presentation and quality of written reports submitted prior to this meeting.

All three participants were of exceptional quality. One senior investigator said that any of the three could easily be a Master's Thesis at his Institution. Therefore, with the consent of the President and Treasurer of the Academy, the monetary prizes of first and second place will be combined with sufficient funds from the Academy to make three equal awards and we will award three way tie for first place with awards of $20.00.

The three winners, alphabetically, are 1) Mr. William Dooley of Samford University. His paper was titled "The Effects of Adrenal Auto-Transplantation on Granulosa Neoplasms in the Rat;" 2) Mr. Michael Fountain of Samford University. His paper was titled "Spontaneous Development of Mammary Tumor in *Rattus norvegicus*;" 3) Mr. William Phillips of The University of North Alabama. His paper was titled "Differentation Between Thrombocytes and Small Lymphocytes in the Cardiac Blood of the Cottus Carolinae.

The proposals for research grants from the following students were chosen to be funded. They are

Hall Blaine Ensor, University of Alabama, Tuscaloosa	$200.00
Guido Dingerhus, Samford University	200.00
Earle Bentley, University of Alabama, Birmingham	200.00
William Dooley, Samford University	200.00
Chang-Sung Tang, University of Alabama, Birmingham	200.00
Michael Fountain, Samford University	200.00
Doris Ann Black, Samford University	175.00

Each of these winners will receive a letter from the Chairman of the Research Committee confirming these awards. The monetary grants will come from the treasurer.

REPORT OF THE NOMINATING COMMITTEE
(R. T. Gudauskas, Chairman)

"The Nominating Committee submits herewith the following nominations for elective offices:"

President 1976-1977

Urban L. Diener
Auburn University

President-Elect 1976-1977

James C. Wilkes
Troy State University

Secretary 1976-1979

Kenneth Ottis
Auburn University

Counselor, AJAS 1976-1979

Faye Wells
University of North Alabama

Board of Trustees 1976-1979

William Barrett, Southern Research Institute
Emmett Carmichael, University of Alabama, Birmingham
Howard Carr, Auburn University
G. O. Spencer, Harvest, Alabama

The Nominating Committee expresses appreciation to members of the Academy who suggested nominations for the various offices.

Biological Sciences:

Vice-President: Carl Dixon, Auburn University
Vice-Chairman : Margaret Miller, University of South Alabama

Chemistry:

Vice-President: T. G. Jackson, University of South Alabama
Vice-Chairman : William Paudler, University of Alabama, Tuscaloosa

Geology:

Vice-President: Robert Cook, Auburn University
Vice-Chairman : George Brockman, University of Alabama, Birmingham

Forestry, Geography and Conservation:

Vice-President: Eugene Wilson, Mobile, Alabama
Vice-Chairman : Howard Johnson, Jacksonville State University

Physics and Mathematics:

Vice-President: William L. Alford, Auburn University
Vice-Chairman : Aldo Forte, University of Alabama, Huntsville

Industry and Economics:

Vice-President: A. Wayne Lacy, Auburn University, Montgomery
Vice-Chairman : Billy J. Bond, Muscle Shoals, Alabama

Science Education:

Vice-President: Dan Whitson, Decatur, Alabama
Vice-Chairman : Gordon Bliss, Alabama State University, Montgomer

Social Sciences:

Vice-President: Charles G. Summersell, University of Alabama
Vice-Chairman : Henry S. Marks, Huntsville, Alabama

Medical Sciences:

Vice-President: George S. Hand, University of Alabama, Birmingham
1st Vice-Chairman : Charles Baugh, University of South Alabama
2nd Vice-Chairman : Richard Shoemaker, University of Alabama, Birmingl

Engineering:

Vice-President: Reynold Q. Shotts, University of Alabama
Vice-Chairman : Walker H. Land, Endwell, N. Y.

Anthropology:

Vice-President: Avery C. Church, University of South Alabama
Vice-Chairman : Robert Fornaro, University of South Alabama

Dr. Gudauskas moved that "the above nominations for elective offices be accepted by acclaimation." The motion was seconded by Dr. Hand. Motion carried.

REPORT OF THE CHAIRMAN FOR REGIONAL SCIENCE FAIRS
(G. Twellmeyer)

"The seven Regional Science Fairs of Alabama have all operated successfully and are sending two Finalists to the International Science and Engineering Fair in Denver, Colorado, May 10-15. Finalists winning in their respective region are as follows:"

CENTRAL REGION: Samford University Dr. Ben Chastain, Coordinator	Miss Winifred Bragg Miss Beckey Brockman
MOBILE REGION: Spring Hill College Mrs. R. L. Crawford, Coordinator	Miss Patricia Harrell Mr. Kenneth Kirkland
EASTERN REGION: Auburn University Dr. Michael Friedman, Coordinator	Miss Cathy Beall Mr. Steve Hearon
NORTH REGION: The University of Alabama in Huntsville Mr. Charles Markin, Coordinator	Mr. J. J. Young Mr. Lee Castle
NORTHEASTERN REGION: Jacksonville State University Mr. C. J. McSpadden, Coordinator	Miss Linda Ann Jennings Mr. Robert M. Thompson
SOUTH REGION: Troy State University Dr. William Norman, Coordinator	Miss Terri Porter Mr. Greg Howard
WESTERN REGION: University of Alabama Tuscaloosa Mr. J. L. Nisbit, Coordinator	Mr. Steve Odewahn Mr. Neil Moss

REPORT OF THE GORGAS SCHOLARSHIP FOUNDATION, INC.
(C. E. Feazel)

"The Gorgas Scholarship Foundation announced today that it has selected the winner and alternates from the finalists in the 1976 Alabama Science Talent Search. The search was held at the meeting of the Alabama Academy of Science at the University of South Alabama.

The winner of the cash award is Mildred Gibson Shofner, 914 Fagan Springs Drive, Huntsville, Alabama, from Randolph High School.

Alternates:

Eighth: Lisa Dianne Landers, Bradshaw High School.

Seventh: Margie Lucile Allen, Childersburg High School.

Sixth: Winifred Diane Bragg, Parker High School.

Fifth: Lynnett Clark, Parker High School.

Fourth: Martha Elizabeth Durant, Jackson High School.

Third: Velda Denise Pugh, Parker High School.

Second: Robin Lynette Richards, Bradshaw High School.

First: William R. Cadenhead, Jr., Bradshaw High School.

The finalists for the Gorgas competition were selected on the basis of their high school records and their entries in the national Science Talent Search for the Westinghouse Science Scholarships and Awards, administrated by Science Service. Miss Shofner, Miss Allen, Miss Durant, and Miss Landers were named to the "Honors Group" in the national search.

Winners and alternates in the Gorgas contests receive offers of tuition scholarships to colleges and universities in Alabama for the study of science. The Gorgas Foundation is named for General William Crawford Gorgas, the Alabama physician who conquered yellow fever in the Panama Canal Zone while serving as Surgeon General in the U. S. Army. The purposes of the Foundation are to promote interest in science and to aid in the education of promising students."

ALABAMA JUNIOR ACADEMY OF SCIENCE-JUNIOR SCIENCE AND HUMANITIES SYMPOSIUM (Faye B. Wells)

Winners--Alabama state paper competition, University of Alabama in Birmingham, February 21, 1976:

Biological Sciences

** First--Russell Turner, Bradshaw High School, "Mensuration and Analysis of the Electrical Potential Rhythms of the Nervous Systems of *Rana catesbeiana*"

* Second--Donna Worley, Opp High School, "Determining the Effects of Various Amounts of Caffeine on Chicken Embryos"

Humanities

* First--Kim Trawick, Cottonwood High School, "A Dyslexic Child"

* Second--Billie Von Marsh, Opp High School, "The Girl's Point of View: An Opinion Study of Title IX"

Mathematics and Engineering

* First--Linda Jennings, Childersburg High School, "Polyhedral Numbers and Their Projections in Dimensional Space"
Second--Lee Castle, Randolph High School, "Designing and Building a Nitrogen Laser Syatem"

Physical Science

* First--Steve Odewhan, Tuscaloosa High School, "Astrophotography"
Second--Scott Nettles, Andalusia High School, "The Amateur Production of Photographic Paper"

Awards presented at the annual meeting, University of South Alabama, Mobile, Alabama, April 8-10, 1976:

AAAS Award

Girl--Loretta Phillips, Tuskegee Institute High
Boy--Earnest Ray McKee, Phillips High School, Birmingham

Research Grant Award

$125.00 to Ricky Bajah, Robert E. Lee High School, Montgomery
$25.00 to Cassandra Evans, Tuskegee Institute High School

The AJAS Officers' Award

$200.00 to Paul Lightsey, Childersburg High School

The Henry Walker Scholarship

$500.00 to Gloria McCloud, D. C. Wolfe High School, Shorter

Outstanding Teacher Award

Mrs. Margo Saddler, New Hope High School, New Hope

Honorable mentions went to:
Robert Sol Davis, Huffman High School
Billy C. Sanders, Robert E. Lee High School, Montgomery

Outstanding Region

Central Region, Mrs. Mabel Phillips, Regional Counselor

*Students to represent Alabama at the National JSHS Meeting, Washington, D.C., May 19-22, 1976.

**To read at the National JSHS Meeting.

Old Business: None

New Business: None

Dr. Tom Denton introduced the incoming president, Dr. Diener. It was announced that all abstracts be sent to Dr. Carrington. Dr. Tom Denton and Dr. Danice Costes were recognized for their contributions to the Academy. The meeting was adjourned by President Diener at 12:00 noon.

Notes

THE JOURNAL

OF THE

ALABAMA ACADEMY OF SCIENCE

AFFILIATED WITH THE
AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

VOLUME 47 **OCTOBER, 1976** **NUMBER4**

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The Journal of the Alabama Academy of Science is published four times a year and is sent without charge to all members of the Academy.

The Journal is indexed in Biological Abstracts, Chemical Abstracts, America: History and Life, and Historical Abstracts.

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FREDERICK, PRINCE OF WALES: A CASE STUDY OF HANOVERIAN FAMILY CONFLICT

Richard Glen Eaves
Department of History
Auburn University
Auburn, Alabama 36830

The Georges and their eldest sons detested each other, and Frederick Louis, Prince of Wales, is surely in the mainstream of this lamentable tradition. Frederick, born in Hanover on 20 January 1707, did not come to England when his father, George II, acceded to the British throne, but instead was left behind in Hanover under a governor until he was almost twenty-two years of age. George II had wanted to leave Frederick in Hanover as heir to that electorate and have his younger son, William, established as heir to the British Crown. Due to the likelihood that members of Parliament would soon begin an inquiry into the reason the prince was not brought to England, George II finally consented in 1728 to send for Frederick. Moreover, King George had discovered the prince's secret plan to marry Princess Wilhelmina of Prussia.[1] Frederick's marriage plan had developed partly because George I and Frederick William I of Prussia had considered arranging a double marriage alliance as early as 1723. George I was to have his grandson, Frederick, marry a Prussian princess and Frederick William I planned to have his son, Frederick, marry a daughter of the Prince of Wales. These monarchs were too quarrelsome with each other, however, for the marriage plans to reach fruition.[2] Since George II opposed such a marriage, he had his son brought over to England where the prince would be watched more closely. Frederick arrived in England on 7 December 1728 as an unwelcome guest of his parents.[3]

When he arrived in England his governor told the queen that the prince was vicious and had base vices. In contrast to his father, Frederick did have certain qualities which made him reasonably popular. He soon gained a reputation for giving to the poor and having concern for needy people.[4]

Frederick was at first in the king's favor, but he soon encountered family difficulties. That he quarrelled with the king and queen after coming to England was not entirely Frederick's fault. George II had refused to pay the debts which the prince had contracted in Hanover.[5] In drawing up the civil list on 27 June 1727, Parliament had approved the amount of £800,000, of which £100,000 was designated for the prince, subject to the king's approval. George II decided that £2,000 per month from the civil list plus the income from the Duchy of Cornwall of some £10,000 each year would provide a very adequate income of approximately £34,000 per year for his son. The Opposition, those in Parliament opposing Crown policies, began to tell Frederick that he was being underpaid and mistreated, and that he should receive the £100,000 which Parliament had stipulated for him, the same allowance his father received as Prince of Wales. George II steadfastly maintained that the £34,000 income was sufficient for the prince until he married.[6]

A strong opposition faction had existed before Frederick came over to England. Sir Robert Walpole, the chief minister, was jealous of the great ability of William Pulteney, the former secretary of war, and did not give him a high office. Consequently, Pulteney was angry toward Walpole.[7] Henry St. John, Lord Bolingbroke, had been secretary of state under Queen Anne, and had been impeached in George I's reign for his role in aiding Catholic James Stuart's quest for the British throne. Bolingbroke had fled to France in 1715, but was allowed to return to England in 1723 because of the intercession by the Duchess of Kendal, George I's mistress.[8] By 1726 Lord Bolingbroke realized that he had no opportunity for advancement in government so long as Walpole was chief minister. Consequently, Bolingbroke and Pulteney joined forces, hoping thereby to force Walpole out of office. They attacked Walpole in their newspaper, *The Craftsman*, a publication which began in 1727 and continued for ten years. Pulteney and his closest associates, William Shippen, a notorious Jacobite (one who supported the exiled Catholic Stuarts), and Sir William Wyndham, were all members of Parliament. Together with Bolingbroke they had been able to build a strong opposition prior to Frederick's arrival in England.[9]

After Frederick came to England and experienced disagreements with his family, Bolingbroke was able to gain much influence over the prince. Those ready to rally around Frederick in opposition to the Crown included the following: William Pulteney; William Wyndham; Sir Richard Temple, Lord Cobham; and the wealthy Bubb Dodington. Other, younger politicians eager to gain Frederick's favor were George and Richard Grenville, William Pitt, and George Lyttelton, all of whom eventually became members of Frederick's household.[10]

Opposition leaders close to the prince lost no opportunity to magnify his differences with the king. They wanted the prince to have a separate residence where politicians could gather around him at his court and add to the strength of the Opposition. Sir Robert Walpole was against a separate residence for Frederick because it would give the prince more power.[11]

The first two Georges were frequently in Hanover where they might stay for several months at a time. George I was absent from England seven times during his reign, and George II twelve times. When George II went to Hanover in 1729 the prince had hoped to serve as regent, but the king selected Queen Caroline for this role, leaving Frederick very disappointed.[12]

Another area in which Frederick felt thwarted concerned his strong desire to get married. He had been very enthusiastic when Sarah Churchhill, Duchess of Marlborough, offered him £100,000 in 1727 as a dowry if he would marry her granddaughter, Lady Diana Spencer. The Duchess of Marlborough was practically being ignored at the court of George II, and both she and the prince thought the secret marriage plan would be a good way to irritate the king.[13] News leaked out about the plans, however, and Walpole squelched the proposals.

Frederick rejected the queen's attempt to have her close confidant, Lord John Hervey, control him. Eventually the prince took over Hervey's

mistress, Miss Anne Vane, and thereafter Hervey had an intense hatred for the prince. In June of 1733 Miss Vane gave birth to Fitz-Frederick Vane, whom Frederick recognized as his son.[14] The queen immediately dismissed Anne Vane from her post as maid of honor, whereupon Frederick provided a house for her and gave her an allowance of £1600 per year.[15]

The Opposition hoped to profit by divisions within the royal family and to gain the prince for their side. Some government officials tried to mediate differences between Frederick and the king, but they actually cared little for either of them. One group of the prince's advisors was concerned lest he be blamed for the family rupture more than his parents. Dodington, Frederick's principal advisor, persuaded him to attend the king's levée on 1 January 1734, hoping thereby to demonstrate to all that the king would not speak to the prince. Hervey found out about this plan and suggested that the queen persuade George II to act cordial toward Frederick at the levée, thereby lessening gossip against the Crown for ill treatment of the prince. Hervey took this occasion to inform the queen that even close friends of the Crown believed Frederick should be given more income from the civil list in order to induce him to cease his opposition. The queen was angry at such talk, and asserted that Frederick received quite enough money. Hervey also questioned the queen about why Frederick was not allowed to maintain a separate household. Her only answer was that the king did not wish it to be so. According to Hervey, the reason was that the king and queen hated their son so much that they would rather put themselves to inconvenience than to make the prince happy.[16] George II's favorite epithets for his son were "puppy, liar, scoundrel, hypocrite, and rascal."[17]

Petty quarrelling continued within the royal family. Princess Anne, daughter of George II, had married the Prince of Orange in 1734, and Frederick found fault with her getting married before him.[18] Another argument between Anne and Frederick grew out of her supporting the musical performances given in England by the German composer, Georg Friedrich Handel, and Frederick's supporting the Italian musician, Giovanni Battista Buononcini, in order to weaken attendance at Handel's performances.[19] The king and queen were both supporters of Handel, while the prince and nearly all the more important nobility attended the Italian opera at Lincoln's Inn Fields. The squabble finally became so intense that the king would as soon forgive members of Parliament for voting against his measures as for going to the opera at Lincoln's Inn Fields.

Another great irritant to the prince was the fact that the queen had chosen Lord Hervey as her favorite and close companion. Frederick and Hervey hated each other and never spoke at all. The prince told his sisters, Princess Anne and Princess Caroline, that the reason he seldom came to see his mother was because Lord Hervey was usually there and that she "knew he had as lief see the devil as Lord Hervey . . . and consequently kept Lord Hervey there to keep him away."[20]

Frederick continued to demand a marriage arrangement, but his parents opposed such a move. Queen Caroline did suggest Charlotte Amelia of Denmark as a possibility, but she was quite unacceptable to Frederick because of her deformed and retarded condition. It was said the

Danish princess was "old, ugly, crooked, and a dwarf."[21] The queen knew the prince would probably reject her. Some members of the Opposition in Parliament were considering bringing up the issue of Frederick's marriage for debate and urging the king to find the prince a suitable match.

The Opposition in 1734 was becoming bold enough to press for certain reforms. Lord Chesterfield had previously desired a bill to abolish civil disabilities for Catholics. Frederick suggested having such a bill revived and voted upon by Parliament. This plan got nowhere, however, because Walpole squelched the move. It was understood that such a bill would give Frederick much more support among Catholics and Jacobites. The Earl of Egmont was also unsuccessful in his efforts to have an Opposition bill enacted for limiting the number of Parliament members who could be paid for services to the king. Egmont stated that there were 180 such members in 1734. Another reform bill by the Opposition would have insured triennial Parliaments, but this effort failed by a vote of 247 to 184.[22] Frederick apparently hoped to have a separate residence, because in 1734 he bought Carlton House from Lord Chesterfield for £6,000 which he borrowed from his treasurer.[23]

Hoping to avoid driving Frederick completely into the arms of the Opposition, Sir Robert Walpole persuaded George II in 1735 to arrange a marriage for the prince. The king, then in Hanover, chose Princess Augusta of Saxe-Gotha.[24] Frederick had wanted to marry Princess Wilhelmina of Prussia, and was reluctant to accept Princess Augusta. He asked the Prussian ambassador, Baron Borck, to inform Frederick William I that the Prince of Wales still wanted to marry into the king of Prussia's family, a family for which Prince Frederick claimed he had more love than for his own. George II was furious when he learned of the plan through Walpole's interception of Borck's letter.[25] The king rejected the princess of Prussia because he said she had a "madman" for a father.

Queen Caroline advised the prince to get rid of his mistress, Miss Vane, because his fiancée would soon be arriving in England. Frederick agreed, largely because he had already chosen a new mistress, Lady Archibald Hamilton, a married woman with ten children.[26] The Princess of Saxe-Gotha landed at Greenwich in April 1736. Frederick and the princess had an elaborate wedding in the summer, but had to spend their honeymoon at St. James's under the eye of the king and queen.[27]

Several points of friction occurred between Frederick and his parents in 1736. One very irritating event was the king's action in naming Queen Caroline as regent again when he went to Hanover. Frederick believed that he should have been given this post. Once again he felt the king was deliberately suppressing him.[28]

Gin drinking was a popular practice among the masses in England at this time and many people became concerned about excessive drunkenness. Consequently, the Crown had the Gin Act of 1736 enacted with the hope of curbing the use of strong drink by charging high taxes on it. Riots resulted as a form of opposition to this unpopular act. While the act

was being considered, Frederick used the occasion to join in opposition against Crown policy by announcing his sympathy with those who opposed the act. George II was very displeased with the prince's behavior.[29]

Before George II journeyed to Hanover in 1736, he left word that the prince and princess were not to have a separate household. Furthermore, the king ordered that the prince and princess were neither to dine in public nor to drive through the streets on London, because these actions might increase their popularity. During the same year the queen and Frederick argued over Lady Archibald Hamilton being one of the princess' ladies of the bedchamber. Queen Caroline wanted her dismissed because the British public would learn that Lady Archibald was the prince's mistress. Also, George II firmly refused to have Mrs. William Townshend as one of Frederick's women of the bedchamber, because her husband had voted against the Excise Bill.[30] The King was absolutely furious toward those who voted against his bills.

Frederick did win some victories in 1736: the appointment of Lady Archibald Hamilton as one of the Princess' ladies of the bedchamber and the increase of his income to £50,000 per year after his marriage. Yet the prince continued to feel aggrieved, because his political friends had persuaded him that the king was denying him the remaining half of the parliamentary grant of £100,000.[31] Frederick finally convinced Princess Augusta that Lady Archibald was pure, had been slandered, and should be one of her ladies of the bedchamber. Augusta gained the king's permission from Hanover, and Lady Archibald was almost immediately appointed keeper of the privy purse, lady of the bedchamber, and mistress of the robes to the princess with a salary of £900 per year. The queen was angry about Frederick's success in this conflict.

Queen Caroline had a very unhappy year in 1736. While George II was in Hanover with his mistress, the queen was at home in England arguing periodically with Frederick. One disagreement arose at the English court over Princess Augusta's remaining a Lutheran and attending a German Lutheran chapel instead of the Anglican Church. The queen urged the prince to have his wife become an Anglican. Queen Caroline stated her fear that the Anglican clergy and many English people would be angry about her Lutheranism, and Lord Hervey mentioned the requirement that heirs to the throne be Anglican, asserting that this requirement might even be construed to mean his wife. This controversy finally convinced the princess to attend Anglican worship and to abandon her Lutheran faith. Another disagreement erupted over the order of entrance at the church. For a while such order into the church which the royalty attended provided that Princess Augusta pass between the queen and the place where the queen's book lay. After a few Sundays Queen Caroline ordered the princess to come into the church by another door. Frederick refused to allow the change and told the princess that she should go into the chapel with the queen or not at all. The queen was embittered at failing to carry her point.[32]

George II left Hanover on his journey toward England in December, 1736. Many Englishmen were making satirical remarks about George being in Hanover, asking if the huge civil list voted to the king upon his

accession was provided for the purpose of defraying ". . . expenses of his travelling charges, to support his Hanover bawdy-houses in magnificence, and enrich his German pimps and whores."[33] An old, blind, lean, lame horse was turned loose in the streets of London with the following inscription hung on his forehead: "Let nobody stop me--I am the King's Hanover Equipage going to fetch His Majesty and his whore in England." On St. James's Palace gate the following advertisement appeared:

> Lost or strayed out of this house, a man who has left a wife and six children on the parish; whoever will give any tidings of him to the churchwardens of St. James's Parish, so as he may be got again, shall receive four shillings and sixpence reward.
> N.B.--This reward will not be increased, nobody judging him to deserve a Crown.[34]

On his journey from Hanover to England in December of 1736, George II was caught in a storm and almost lost at sea. While awaiting news as to whether or not George II was alive, a crowd in London cheered Frederick and yelled, "Crown him, crown him!"[35] The prince's followers seemed elated, hoping they would shortly become the ruling party. Frederick even entertained the Lord Mayor of London and all the aldermen with a great dinner at Carlton House. According to the queen, Frederick was already strutting about as if he were king, and she charged that he was planning to overthrow his father. George II finally arrived in England in January, 1737, having been delayed by stormy weather for about five weeks. The king's supporters were greatly relieved.

In February, 1737, the prince agreed that leaders of the Opposition might bring up his long-standing allowance grievance for debate in the Parliament. The move was designed to persuade the king to grant Frederick the £100,000 which had originally been designated for him in the civil list. Frederick's main supporters in this matter were George Lyttelton, George Grenville, the Duke of Marlborough, William Pitt, the Duke of Bedford, and Lord Chesterfield. From this time forward, these supporters began to regard the prince as the center of the Opposition. The date set for the debate in Commons was 22 February 1737.[36]

Frederick, his close friends, and various malcontents, were vigorously making all the contacts possible with members of both houses of Parliament. The appeal by the prince to members of Parliament was that he wanted more money so he could do more for his friends. He promised to repay them fully when he became king, which was thought by many people not to be far away in view of the king's poor health. Many of the king's supporters begged him to come out of his bedchamber, thereby showing the people he was not seriouly ill. Reports that the king's death was imminent would only encourage members of Parliament to side with the heir apparent. George II did come out, and it helped his cause. Because he feared that an increase in Frederick's income would add to the prince's power with the Opposition, the king was determined not to yield. Upon learning that Frederick's allowance was to be debated in Parliament, both the queen and her daughter, Princess Caroline, were said to have wished every day that Frederick would die. The queen cursed the hour of his birth, calling him a "nauseous beast" who loved nothing but money.[37]

After a very lengthy debate in Parliament on the allowance of the prince, during which Walpole and others ably defended the king's position, the royal forces were barely able to defeat Pulteney's motion in favor of Frederick's receiving £100,000. The vote was 234 to 204. The victors had shown Frederick to be something of a spendthrift.[38] Carteret, Opposition leader in the House of Lords, introduced the motion there, only to have it overwhelmingly defeated by a vote of 103 to 40. George II's forces had won, as he had expected, but the king and queen were so angry at the prince that they determined to turn him out of St. James's Palace. Only with great difficulty did Walpole finally dissuade them, by reasoning that such action would give the prince a new grievance for the Opposition to exploit. Walpole also did not want the prince to have a separate residence which would become the center for the Opposition.[39]

Sympathizers with the Crown had their own ways of striking against the prince. As an illustration, the church official at St. James's Church began opening the services with the following statement: "I will arise and go to my father, and will say unto him, Father, I have sinned against heaven, and before thee, and am no more worthy to be called thy son."[40] Frederick began to attend church elsewhere.

During the summer of 1737, rumors arose that Princess Augusta was expecting a child. Queen Caroline had done all she could to convince people that Frederick was incapable of having children, and she even tried to persuade Hervey to claim that he was the father of Miss Vane's illegitimate child instead of Frederick. She feared that the pregnancy reports were untrue and were instead an attempt to have a child planted in the prince's household in order to have an heir to the throne. Frederick decided that the child should be born at St. James's Palace instead of in the royal residence at Hampton Court, where the king and queen were then residing. The queen had wanted Walpole to send a message to Frederick ordering him to arrange for the baby to be born at Hampton Court, but Walpole, thinking there was plenty of time, had procrastinated and it was never sent. Early in the night of 31 July 1737 Princess Augusta suddenly began to have severe childbirth pains, and Frederick rushed her by coach to St. James's Palace in London without notifying the king and queen. Several ladies and a surgeon named Vreid were taken along. A baby girl was born at 10:45 P.M. and the royal couple was notified about 1:30 A.M.[41]

Walpole opposed having the baby brought to Hampton Court for fear it might die and the king and queen be accused of murdering it so that the Duke of Cumberland, a son both favored over Frederick, would remain second in the line of succession. George II was enraged at Frederick's action.[42] He had a harsh letter prepared and sent to his son. After enumerating reasons for his anger, the king ordered Frederick and his family to move from Hampton Court to a separate residence as soon as the princess recovered sufficiently to travel.[43] The king ordered the sentinels removed from the prince's doors and gave instructions to his lamplighter that he was no longer to light lamps for the prince.[44] George II also had orders issued to all peers, peeresses, and privy counselors that anyone who went to the prince's court could

not even be admitted to the king's presence.[45] The Duchess of Ancaster lost her pension because her husband was a member of the prince's household, and the king's lamplighter was fired because he disobeyed orders and lighted the lamps outside the prince's house.[46] Frederick was not allowed to take any furniture from his apartments when he left Hampton Court. Sir Robert Walpole had opposed denying the prince the furniture, maintaining that such action would only incite the prince's party in Parliament to further demands that Frederick be given more money since he would have new expenses of buying all his furniture. On this matter, Walpole's counsel was not heeded this time.

On 12 September 1737 the prince, princess, and their household moved from St. James's Palace to a temporary residence at Kew, located just outside London. Lord Carteret, William Pulteney, and Sir William Wyndham soon arrived there, because they were aligned with Frederick in the Opposition. The Duke of Norfolk leased Norfolk House to them, and the prince took Clivedon for his country dwelling.

The quarrel over the birth of Frederick's daughter seemed to cause an irreparable breach between the prince and his parents. George II wished never to hear Frederick's name again, nor ever to see his "nasty face." Queen Caroline said, "I hope in God I shall never see the monster's face again."[47] Her wish came true; within two months after Frederick and his family left St. James's the queen was striken with a fatal illness. She had given strict orders not to let Frederick see her should she become extremely ill. Frederick repeatedly came to London to see his mother, but George II consistently refused his request. Queen Caroline maintained that he only wanted to come so that he could appear to be a dutiful son. She had George II promise that he would consider her simply insane if she called for the prince while dying. She died on Sunday night, 20 November, 1737.[48] Walpole's position was weakened by her death because she had been his staunch supporter since George II had become king.

The prince had acted unwisely in rushing off to St. James's for the birth of his child, and three of his closest advisors among the Opposition, Lord Carteret, Lord Chesterfield, and Pulteney, all shared this opinion. They felt Frederick had given his parents legitimate grounds for complaint. Opposition leaders, however, were divided as to what course of action Frederick should follow. Lord Cobham and Pulteney wanted a reconciliation; Lord Chesterfield and Lord Carteret were against it. Since a public breach had occurred between the prince and his parents, however, the Opposition generally welcomed the opportunity to use him as a leader in their efforts to have dissidents combine and overthrow Walpole's administration.[49]

By 1737 the Opposition leaders had built up strong hopes that the prince would be able to give them considerable help.[50] Frederick, however, did not have adequate finances. From 1737 to 1742 he received about £59,000 income per year, including revenues from the tin mines on his Cornish estates. Maintaining the prince's household was very expensive. As early as 1736 the prince had forty persons in major positions in his service with incomes of £100 per year or more. Of these

forty, eleven were members of Parliament and three were peers. This group gave the prince a paid faction in Parliament.[51] The Duchess of Marlborough wrote in 1738 that the salaries alone for Frederick's household amounted to £25,000 per year.[52] Frederick borrowed money from a number of sources. For example, in 1738 he borrowed £30,000 from London bankers, using his tin revenues as security. He repaid this loan in 1742, but some other loans were never paid. Patronage given through appointments was the primary method used by Frederick to influence politics. Since appointments cost much money, the prince always lacked sufficient funds.[53]

Because of England's violations of the Asiento,[54] Spain was complaining bitterly of English contraband trade with Spanish colonies by 1739. The English, on the other hand, were angered at reports of atrocities by Spaniards to English sailors. There was a growing sentiment in Britain in favor of military action. Sir Robert Walpole, however, opposed war and this position enlivened the Opposition against him. Opposition leaders urged a war against Spain, but at the same time urged a reduction in the armed forces. Frederick would not agree to weakening the military forces, and thereby he contributed to Walpole's success in getting an army bill passed by a vote of 249-164. Thus Frederick deserted the Opposition on the army issue.[55] Frederick and the Opposition continued to press for war against Spain, and in 1739 Walpole was forced to agree to the War of Jenkins' Ear.

Frederick continued his cooperation with the Opposition and by 1741 had given positions with good pay to fifty-four members of his household. Fifteen of these were in Commons; three were closely related to members of Parliament; and three were peers.[56] The 1741 elections resulted in a loss of twelve seats from the administration's majority. Of the 553 members of Parliament elected in 1741, 286 were inclined to be pro-administration, while 267 were likely to oppose. This election of 1741 was highly important because the government now had only a slim majority.

In the Parliament of 1741 a motion to have the king dismiss Walpole lost by a vote of 290 to 106. The Opposition had especially despised Walpole's pacifism, desired a stronger war policy, and criticized Hanover's linkage to the English Crown. By early 1742 the Opposition actually had a slight majority in Commons and on 2 February 1742 Walpole resigned. For twenty-one years Walpole had maintained himself in power. This defeat appears to be the first time a minister had been forced out by a majority opposition while that minister still retained the full confidence of the king.

As for the administration's adherents in early 1742, their number of dependent supporters in Parliament stood at 152, of whom 124 held posts with actual income from the Crown. Some of the others owed their election to administration support. Tories formed about half of the total Opposition strength. The Tories represented the most stable element of the Opposition during the days of Walpole and Pelham. Jacobitism had almost died out in the 1720's. A few Tories under the leadership of William Shippen did continue to speak for the House of

Stuart, but as a real force Jacobitism had sharply declined in the 1720's and was practically dead by 1745.

Although Frederick's personal faction in Parliament was relatively small in 1742, it was important since the Opposition and administration forces were so closely balanced in the Commons. Of the twenty-one members in Frederick's Parliament faction, nineteen were employed in his household and the two others owed their election to his support of them in Cornwall.[57] Some of the more important offices and positions existing in the prince's own household were as follows: master of the household, treasurer of the household, groom of the stole, keeper of the privy purse, gentlemen of the bedchamber, grooms of the bedchamber, gentlemen ushers, master of the horse, ladies of the bedchamber, maids of honor, mistress of the robes, bedchamber women, princess' vice-chamberlain over menservants, secretary, auditor general, secretary for Scottish affairs, gentlemen in waiting, and clerks of the household.[58]

After Pulteney was removed from the Opposition in early 1742 by being given a peerage, he was able to accomplish a master stroke for the forces in the Crown. Upon being created Earl of Bath, he met with Frederick and persuaded the prince to support the new government which would be led by John, Lord Carteret. As a reward for his support, Frederick would receive an additional £50,000 in income and obtain government posts for some members of his household. Furthermore, Lord Bath was instrumental in persuading the prince to write a conciliatory letter to the king and then to meet with his father at St. James's for the first time in several years. Where Walpole had failed to effect reconciliation, Lord Bath had succeeded.[59]

Frederick left the Opposition now that his allowance was increased to £100,000, his peace made with the king, and some of his friends appointed to government posts. For example, Lord Carteret became a secretary of state,[60] and Lord Archibald Hamilton had a seat at Dartmouth bestowed upon him. Others of Frederick's faction gained offices, too.[61] Frederick was naturally pleased to have two of his close friends, Lord Bath and Lord Carteret, become important figures in the government. From the Crown's position, it had increased its supporters in Parliament by some thirty-five to forty members with the acquisition of the followers of Lord Bath, Lord Carteret, and the Prince of Wales. George II even restored the prince's guard, which had been witheld for five years. The prince's favorite, Lord Middlesex, was given a post in the government in 1743.[62]

During the years of reconciliation, from 1742 to 1747, a continental war was raging and a civil war occurred in Britain. In this period, after five years of being active in politics. the prince did not act with the Opposition, believing that a patriotic prince should refrain from activities which would further endanger the war effort. There was an active Opposition during these years, however, which deeply resented George II's policy of using British resources in the defense of Hanover during the War of the Austrian Succession.[63] On a motion in Parliament on 10 December 1742 to grant £265,190 for maintaining 16,000 Hanoverian troops, there was a sharply split vote. Royal forces carried the motion

by a vote of 251 to 184.[64] William Pitt and the Duke of Bedford were two Opposition leaders who vehemently opposed supporting the Hanoverian troops with British money.[65] Frederick himself consistently favored the eventual separation of Hanover from Britain, but he did not press this view during the war because it would have meant sacrificing Hanover to Prussia. The prince did intend to effect separation when he became king.[66]

By the summer of 1743, the War of Jenkins' Ear had merged into the War of the Austrian Succession. Frederick was disappointed that his request for a command in the army was refused by the king, but he did not return to the Opposition at this time. When the Young Pretender, Charles Edward Stuart (James II's Catholic grandson, who had grown up in France), landed in Scotland on 25 July 1745, many Englishmen became quite alarmed. Frederick's request to command the English forces against Charles Edward was denied by the king. Instead, the Duke of Cumberland, younger brother of the prince, was recalled from the continent and given the command. Frederick's desire for military leadership was consistently rejected by the king both at home and abroad.[67] The Duke of Newcastle wrote to Lord Chesterfield in January of 1746 that the Prince of Wales was very resentful at being refused the command in Scotland against the Young Pretender.[68] After the Rebellion of 1745 had been suppressed, the Duke of Cumberland returned to London as a military hero. Frederick was bitter about his younger brother's winning all the military glory.

Horace Walpole, in writing to Horace Mann in March 1746, stated that Frederick was planning a new Opposition.[69] In early 1747 the Prince of Wales announced plans for joining the Opposition. Frederick charged that the Duke of Newcastle and his brother, Henry Pelham, now the prime minister, held the king in virtual slavery and were planning to change the succession to the Duke of Cumberland in order to perpetuate their power. Frederick decided to form an alliance with the Opposition and free the king from what he termed "tyrannical ministers." He would even align with the Tories, some of whom had been leading Jacobites, in order to accomplish his ends. Princess Augusta opposed Frederick's moves and kept the Pelhams posted on his plans.[70] The center for Frederick's new Opposition was Leicester House, which he had acquired in 1743.

Administration forces decided to call for elections in 1747 instead of waiting until 1748. Horace Walpole wrote that he believed the government leaders planned the election at this time because they knew the prince was not prepared.[71] Frederick spent a large amount of money in this election. Horace Walpole commented as follows about Frederick's plans: "They say the Prince has taken up two hundred thousand pounds, to carry elections which he won't carry;--he had much better have saved it to buy the Parliament after it is chosen."[72] Walpole's prediction proved correct, because the election of 1747 proved to be a great victory for the Pelhams and the Crown. The administration forces won 341 seats to the Opposition's 216. There were at least 120 Tories in the new Parliament, and by the end of 1750 most of these Tories had allied with Frederick's faction.[73] The prince's personal party numbered thirty in the new Parliament, and twenty-seven of these were on his payroll.[74]

Frederick did not slow his efforts for the Opposition after the election disappointment. Instead, he began on 12 December 1747 to subsidize a weekly Opposition newspaper, edited by George Cadwallader. The name of the newspaper was the *Remembrancer*, and it existed until 1 June 1751. The prince had one of his personal supporters, James Ralph, write articles for this paper, which attacked corruption, charged that ministers were infringing on powers of Parliament, and maintained that there was ruinous taxation and government depression of trade. It also opposed having a standing army, denounced excessive harshness in military discipline, and labeled the Treaty of Aix-la-Chapelle a bad peace. Articles appeared contrasting the virtures of Prince Frederick with the vices and wickedness of the Duke of Cumberland, who was Captain-General of the army. Cumberland's plans for a more severe Mutiny Bill and greater discipline in the military were condemned. Finally, it held that the only hope for the country was the Prince of Wales.[75]

The number of servants to the prince varied. In 1736 there were only forty persons in major positions of service to the prince with salaries of £100 per year or more. There were sixty-four in 1747 and seventy-one in 1751. Salaries ranged widely. The treasurer of the household and groom of the stole received £1,200 per year; the master of the horse received £1,000 per year; gentlemen of the bedchamber received £600 per year, and grooms only £400 per year. Others received lesser amounts. The prince could increase the number of posts for members of Parliament as long as his finances would allow it.

Of the seventy-one people in the prince's service in 1751, twenty-eight were members of the Commons; four were peers of England or Scotland; six had been in the previous Parliament; one had been a candidate in the last election; and at least five members of Parliament were closely related to others in Frederick's service. While the prince's patronage could never approach that of the king, he did build up a substantial following which represented one important group in the Opposition.[76]

In a statement of his political objectives, Frederick promised in June 1747 that upon his accession he would exert efforts to abolish all distinction of party, because most of the calamities of the country were caused, in his view, by parties and factions. Furthermore, it would be his aim to allow any gentlemen paying £300 land tax to serve as justices of peace in their respective counties. He would establish a large militia. No military officers under the rank of colonel in the army and rear-admiral in the navy would be allowed to sit in Parliament, if he could obtain such legislation from Parliament. He would have investigations into the conduct and abuses of government officeholders. An allowance of £800,000 from the civil list would be his only source of income, and he would end all the hereditary revenues of the Crown.[77] George III's later giving up all hereditary revenues and accepting an income of £800,000 per year from the civil list was possibly a result of Frederick's own political objectives during the last few years of his life. Also, the return of a number of old Tories to the government under George III probably occurred because of Frederick's promise to

remove old party distinctions which he claimed had persisted too long.[78] Frederick planned eventually to separate Hanover from the British Crown and turn it over to his second son, Edward. Prince George, Frederick's eldest son, would have been compensated for losing Hanover by receiving an extra £100,000 per year from Parliament.[79]

Supporters of Frederick had continued to increase in Parliament after 1747, and Horace Walpole wrote that the prince was considered head of a faction which numbered 137 by 1749.[80] As early as July 1749 the prince had already promised various members of his household faction important posts in the government when he became king. Dodington was promised a peerage; Henry Furnese was in line for the treasury; and Sir Francis Dashwood was to become treasurer of the navy or cofferer.[81] Lord Egmont would be a secretary of state, and Dr. Lee would be chancellor of the exchequer. A few Tories were to obtain offices. Frederick's promises of future appointments thus drew a number of people into his following.[82]

By 1750 many people believed that Frederick was about to force Newcastle out of office, and defections to the prince's party grew in number. (Frederick's dislike for the king and the Duke of Newcastle was increased in 1749 when the duke was created chancellor of the Univeristy of Cambridge, a post the prince had sought for himself). The Duke of Bedford made approaches to Frederick, and Lord Cobham made an alliance between his followers and the prince's faction.[83] Just as the prince's party was attaining great strength, however, he became ill on 6 March 1751. Frederick told Dodington that he had caught cold the previous day at Kew and had been bled. He was still sick on March 14, although he had been twice bled and had had blisters put on his back and legs. On March 20 he was seized with a fit of coughing and choked to death.[84]

People were divided in their reaction to Frederick's death. Some compared his demise to those of the Black Prince, son of Edward III, and Prince Henry, son of James I, both of whom were robbed by death from fulfilling their expected greatness on the throne.[85] When told of his brother's death the Duke of Cumberland made the following sarcastic remark: "It is a great blow to the country, but I hope it will recover in time."[86] Lord Cobham received the following written statement from Frederick's eldest son, Prince George: "My Lord,--I am obliged to you for your affectionate expressions of concern for my misfortune in losing the best of fathers."[87] Frederick's creditors were sick at heart, because their gamble that he would become king and repay them had been crushed.

As to Frederick's faction, it largely dispersed in great disappointment. The Duke of Bedford wrote that just at the time when the government ". . .expected some blow to the administration, the sudden death of the Prince of Wales broke up the most formidable body of their adversaries."[88] George II stated that he was glad his son had died.[89] One Jacobite wrote the following poem about Frederick's death:

Here lies poor Fred, who was alive and is dead.
We had rather it had been his father,
Had it been his brother, better'n any other,
Had it been his sister, no one would have missed her,
Had it been the whole generation,
All the better for the nation,
But it's just poor Fred, who was alive and is dead,
There is no more to be said.[90]

Immediately after the death of the Prince of Wales, Princess Augusta and Lord Egmont destroyed Frederick's private papers to prevent the king's seizing them. Egmont kept his own copies, however, which are now in the British Museum. In order to win the favor of George II and protect her son's hopes of becoming king, the princess dismissed all the prince's old friends who were despised by the king. Even Egmont was ousted. Dr. Lee, who was not strongly disliked by George II, did stay on in the princess' household until he resigned in 1757.[91] As early as 1 April 1751 Horace Walpole observed that the king and princess had grown quite fond of each other and that Princess Augusta had been discouraging all opposition to the Crown.[92]

Thus Princess Augusta's reaction to her husband's death was to mend relations with the king in order to insure her son's eventual succession to the English throne. George II rewarded the princess by naming her Regent-designate so that should he die before the new Prince of Wales reached maturity, Augusta would become regent. In this manner Princess Augusta dissolved Frederick's personal faction, for which he had held such high hopes.[93]

CONCLUSION

It appears conclusive that neither Frederick nor George II was tactful in working out differences which arose between them. Several areas of dissatisfaction contributed to Frederick's joining the Opposition. He was unhappy about having a much smaller allowance than his father had had as Prince of Wales. This irritant was compounded in view of the fact that Parliament had intended for Frederick to get the same allowance that his father had received as Prince of Wales. Failure of George II to arrange a suitable marriage for the prince was another area of complaint. The prince was also bitter because the king refused for so many years to permit him to have a separate residence. When Frederick did move into a separate residence, it was because the king and queen had ordered him to leave the royal plaace as a result of the furor which erupted over the birth of Frederick's first child.

The prince was also angry because his brother, the Duke of Cumberland, obtained military commands while Frederick was refused all requests for a command. Another complaint of the prince was that George II would never allow him to serve as regent while the king was visiting in Hanover. All of these frictions certainly can be seen as contributing factors behind Frederick's opposition to his father.

Frederick's ability to form a reasonably significant personal faction within Parliament was based on his allowance being raised in 1742

to £100,000 per year and his having some additional revenues from the Duchy of Cornwall. The prince used these funds to increase the posts within his household and to fill many of these positions with members of Parliament, most of whom would usually vote to please him.

The death of the prince in 1751 exploded plans to have members of his personal faction eventually take over the important posts in the British government upon his accession. Frederick's faction was quickly dissolved by Princess Augusta, who was careful to win the favor of George II in order to make life for herself and her son George more comfortable.

FOOTNOTES

[1]John B. Owen, *The Eighteenth Century, 1714-1815* (Totowa, New Jersey, 1975) pp. 27-28; J. H. Plumb, *The First Four Georges* (London, 1956), p. 55; Reginald Lucas, *George II and His Ministers* (London, 1910), p. 45.

[2]Basil Williams, *The Whig Supremacy, 1714-1760,* 2nd ed. (Oxford, 1962), p. 40.

[3]Lucas, p. 45.

[4]W. R. Irwin, "Prince Frederick's Mask of Patriotism," *Philological Quarterly,* XXXVII (July, 1958), 369.

[5]Matthew Hodgart (ed.), *Horace Walpole: Memoirs and Portraits* (New York, 1963), p. 7.

[6]Romney Sedgwick (ed.), *Lord Hervey's Memoirs* (New York, 1963), pp. 18-19. Hereinafter cited as *Hervey's Memoirs.*

[7]Plumb, p. 76.

[8]Averyl Edwards, *Frederick Louis Prince of Wales, 1707-1751* (London, 1947), p. 25.

[9]Plumb, pp. 76-77.

[10]Edwards, pp. 26, 29.

[11]Plumb, p. 78.

[12]Edwards, p. 25.

[13]Bonamy Dobrée, *Three Eighteenth Century Figures: Sarah Churchill, John Wesley, Giacomo Casanova* (London, 1962), p. 61.

[14]Sir George Young, *Poor Fred: The People's Prince* (London, 1937), pp. 48-50.

[15]Edwards, p. 31.

[16]*Hervey's Memoirs*, pp. 35-36.

[17]Lucas, p. 37.

[18]*Hervey's Memoirs*, pp. 41-42, 51-52.

[19]Peter Quennell, *Caroline of England* (New York, 1940), 169.

[20]*Hervey's Memoirs*, pp. 43-44.

[21]Romney Sedgwick, "Frederick, Prince of Wales," *History Today* XI (June, 1961), 410.

[22]Young, pp. 71-73.

[23]*Hervey's Memoirs*, p. 59.

[24]Young, p. 77.

[25]Edwards, p. 50.

[26]*Hervey's Memoirs*, p. 89.

[27]Plumb, p. 80.

[28]Young, p. 88.

[29]Edwards, p. 64.

[30]*Hervey's Memoirs*, p. 120; Young, p. 88; Edwards, p. 64.

[31]Sedgwick, "Frederick, Prince of Wales," p. 411.

[32]*Hervey's Memoirs*, pp. 126-128.

[33]Quoted in *Hervey's Memoirs*, p. 140.

[34]Quoted in *Hervey's Memoirs*, p. 141.

[35]Young, p. 99.

[36]*Hervey's Memoirs*, p. 152; Young, p. 97; Edwards, pp. 81-82.

[37]Historical Manuscripts Commission, *Manuscripts of the Earl of Egmont: Diary of Viscount Percival, Afterwards First Earl of Egmont*. Edited by R. A. Roberts (London, 1920), II, 352-354. Hereinafter cited as *Egmont's Diary; Hervey's Memoirs*, pp. 180-183.

[38]See William Cobbett, *The Parliamentary History of England from the Norman Conquest in 1066 to the Year 1803* (London, 1806-1820), IX, 1352-1454; Young, pp. 108-109; *Egmont's Diary*, II, 355.

[39]*Egmont's Diary*, II 353, 356; Edwards, p. 89; Cobbett, *Parliamentary History*, IX, 1448.

[40]Quoted in Young, p. 111.

[41]*Hervey's Memoirs*, pp. 201-202; Young, p. 114; Edwards, pp. 91-92.

[42]Young, pp. 122, 126.

[43]*Hervey's Memoirs*, pp. 217, 222-223.

[44]Quennell, p. 227.

[45]*Egmont's Diary*, II, 432; *Hervey's Memoirs*, p. 225.

[46]Young, p. 127.

[47]*Hervey's Memoirs*, pp. 220-221, 225-226; See also *Egmont's Diary*, II, 432.

[48]*Hervey's Memoirs*, pp. 231, 237-240, 244, 263.

[49]Young, pp. 131-132; Edwards, p. 101.

[50]Archibald S. Foord, *His Majesty's Opposition, 1714-1830* (Oxford, 1964), p. 128.

[51]A. N. Newman, "The Political Patronage of Frederick Lewis, Prince of Wales," *Historical Journal*, I, No. 1 (1958), 70, 72.

[52]Young, p. 143.

[53]Newman, "The Political Patronage of Frederick Lewis, Prince Wales," pp. 70-72.

[54]Britian gained the Asiento from Spain by the Treaty of Utrecht in 1713. It gave the British a 30-year monopoly on the slave trade to Spain's Latin American colonies and the right to send one ship each year to trade with these same colonies. The British violated the agreement by sending many ships to trade here.

[55]Edwards, p. 129; Young, p. 144.

[56]Newman, "The Political Patronage of Frederick Lewis, Prince of Wales," p. 73.

[57]John B. Owen, *The Rise of the Pelhams* (London, 1957) pp. 3, 6-8, 33-34, 45, 67-68, 79-80, 90.

[58]Newman, "The Political Patronage of Frederick Lewis, Prince of Wales," pp. 68-70.

[59]Owen, *The Rise of the Pelhams*, pp. 99, 336.

[60]Lord John Russell (ed.), *Correspondence of John, Fourth Duke of Bedford* (London, 1842), I, xxv. Hereinafter cited as *Bedford's Correspondence*.

[61]Owen, *The Rise of the Pelhams*, p. 117.

[62]Edwards, pp. 100, 137-138.

[63]Young, pp. 176, 179.

[64]William James Smith (ed.), *The Grenville Papers: Being the Correspondence of Richard Grenville, Earl Temple, K. G., and the Right Honorable George Grenville, Their Friends and Contemporaries,* (London, 1852), p. 20, Hereinafter cited as *Grenville Papers.*

[65]*Bedford's Correspondence,* I, xxx.

[66]Young, pp. 184-185.

[67]Edwards, pp. 139, 145; Young, p. 190.

[68]Sir Richard Lodge (ed.) *Private Correspondence of Chesterfield and Newcastle, 1744-1746* (London, 1930), p. 98.

[69]Paget Toynbee (ed.) *The Letters of Horace Walpole: 1743-1750* (Oxford, 1903), II, 181. Hereinafter cited as *Letters of Horace Walpole.*

[70]Sedgwick, "Frederick, Prince of Wales," pp. 411-412.

[71]*Letters of Horace Walpole,* II, 277.

[72]*Letters of Horace Walpole,* II, 280.

[73]A. N. Newman, "Leicester House Politics, 1748-1751," *English Historical Review,* LXXVI, No. 301 (October, 1961), 579-580.

[74]Sedgwick, "Frederick, Prince of Wales," p. 412; See also *Memoirs of the Administration of the Right Honourable Henry Pelham, Collected from the Family Papers, and Other Authentic Documents.* Edited by William Coxe (London, 1829), II, 50-52. Hereinafter cited as *Pelham Memoirs.*

[75]Irwin, "Prince Frederick's Mask of Patriotism," pp. 370-371.

[76]Newman, "The Political Patronage of Frederick Lewis, Prince of Wales," pp. 70, 74-75.

[77]*Bedford's Correspondence,* I, 320-322.

[78]Newman, "Leicester House Politics, 1748-1751," p. 301.

[79]Sedgwick, "Frederick, Prince of Wales," p. 414.

[80]*Letters of Horace Walpole,* II, 360-363.

[81]Henry Penruddocke Wyndham (ed.), *The Diary of the Late George Bubb Dodington, Baron of Melcombe Regis, From March 8, 1749 to February 6, 1761,* 3rd ed. (London, 1785), p. 6. Hereinafter cited as *Dodington's Diary.*

[82]Sedgwick, "Frederick, Prince of Wales," p. 414.

[83]*Pelham Memoirs*, II, 80; Young, p. 214.

[84]*Dodington's Diary*, pp. 96-97.

[85]Irwin, "Frederick's Mask of Patriotism," p. 377.

[86]Quoted in Hodgart, p. 9.

[87]Quoted in *Grenville Papers*, p. 96.

[88]*Pelham Memoirs*, II, 165; *Bedford's Correspondence*, II, 89.

[89]Young, p. 220.

[90]Quoted in Young, p. 223.

[91]Sedgwick, "Frederick, Prince of Wales," p. 414.

[92]*Letters of Horace Walpole*, III, 43.

[93]Sedgwick, "Frederick, Prince of Wales," p. 416.

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THE EFFECTS OF ADRENAL AUTO-TRANSPLANTATION ON GRANULOSA NEOPLASMS IN THE RAT

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ABSTRACT

The objective of this project was to study the effects of adrenal auto-transplantation on cortical function and on neoplasia of the granulosa-theca cells of the ovary in albino SAF/SD *Rattus norvegicus*. Of 175 experimental female rats, 50 were used as controls, 50 represented adrenal auto-transplants, and 75 spleen-to-ovary transfers. After transplantation of the adrenal gland to the fascia surrounding the femoral vessels in the groin, the cortex of the adrenal gland hyper-functioned. Additionally, the chromaffin cells of the adrenal medulla were resorbed. Of the spleen-to-ovary tranfers, in which the spleen was removed and 20% of it relocated within the bursa of the ovary, carcinoma of the granulosa-theca cells developed within 4-10 weeks. Thirty rats, after development of this carcinoma, then underwent adrenal auto-transplantations. Within five weeks of the adrenal auto-transplantation a definite stunting of the growth of this carcinoma had occurred and within twelve weeks had become localized at the site of the ovary. Blood urea nitrogen and 17-ketosteroids were monitored for twelve weeks in each of the aforementioned groups of rats to show the change in adrenal cortical function. Results of these tests and histological studies showed simultaneous adrenal cortical hyper-function after auto-transplantation and decreased growth rate of the ovarian neoplasia.

INTRODUCTION

Adrenalectomies have been used in the treatment of Cushing's disease, Addison's disease, breast cancer and prostate cancer in humans (Hradec, 1973; Guyton, 1959; Dao and Libby, 1969; Horsley *et al.*, 1971; Hanson *et al.*, 1971). However, adrenal transplants have proven successful in the treatment of Cushing's disease and Addison's disease in humans (Kaplan and Shires, 1972; Drucker *et al.*, 1967; Hardy, 1971). Research into the use of adrenal auto-transplants in the treatment of cancer is very rare or non-existent. Previous (unpublished) studies by the authors seem to indicate regression of ovarian neoplasia after adrenal auto-transplantation. This project is unique in that it studied the effects of adrenal auto-transplantation on ovarian neoplasia in rats.

MATERIALS AND METHODS

Albino laboratory rats (*Rattus norvegicus*, SAF/SD strain) were obtained from Southern Animal Farms in Prattville, Alabama. For adrenal auto-transplantation 50 female rats between 150 - 200 gms were anesthetized with Sodium pentabarbital, Nembutal, (60 mg/kg) by

intraperitoneal injection. Surgical conditions were attained within twenty minutes and lasted for approximately ninety minutes. Since transplanted tissue does not grow in the presence of other functional adrenal tissue, a bilateral adrenalectomy was performed before each transplantation of tissue to the fascia surrounding the femoral vessels. The method of Ingel and Griffith was used for the adrenal auto-transplantation (Farris and Griffith, 1971). One week after this operation these rats were monitored at two-week intervals for ketosteroid and blood urea nitrogen (BUN) levels.

The procedure used for the production of ovarian cancer was similar to that used by Muhlbock *et al.* (1958) and Muhlbock and Boot (1958). In 75 rats, a longitudinal incision was made on the left side of the abdomen from the lowest rib to the lower pole of the kidney. The spleen was delivered through the incision with a mall probe. The pedicle was then ligated and the organ excised. A small portion (20%) of the spleen was cut away and stored in Hanks Buffered Saline Solution. The ovarian sac or bursa was then delivered through this same incision, opened, and this portion of the spleen placed within. Success of this procedure depends on the placement of the spleen tissue. If the spleen portion slides away from its close contact with the ovary, cancer will not develop. Laparotomies every two to three weeks were then performed to check on the development of possible ovarian neoplasia. After the development of a neoplasm these rats were monitored for 17-ketosteroid and BUN levels. Thirty of these rats, after development of a carcinoma, underwent an adrenal auto-transplant and then were monitored for the same levels. Fifty rats were used as controls. On other (non-project) rats, sham operative procedures and/or splenectomies were performed and monitored to determine if these variables would statistically change results.

In testing for 17-ketosteroids, urine collected using metabolism cages, was filtered and then hydrolyzed with concentrated HCl. The ketosteroids, which are present in urine as glucuronides and sulfates, were liberated by this hydrolysis and then extracted with 20 ml cold ethyl ether. Extraneous chromogens and estrongenic substances were removed by washes of 2N NaOH. Final measurements were based on the Zimmerman reaction in which m-Dinitrobenzene reacts with the methylene group of the C-16 carbon producing a purple color. Concentration was determined colorimetrically at wave length of 520 nm. To measure the BUN the method of Gentzkow and Masen (1942) was used.

RESULTS AND DISCUSSION

Results of the 17-ketosteroid and BUN tests are recorded in Figures 1 and 2. The operations used to check on the growth of the neoplasm in non-monitored cancer rats revealed that by the sixth week there was metastasis and by the twelfth week there was major abdominal involvement with the carcinoma. Growth of carcinomas after adrenal auto-transplantation revealed an apparent stunting of the growth of the tumor. Histological studies showed an apparent limitation of cancer involvement to the ovary or a remission in every case by the end of the 12-week study period. In every case results from the sham operative procedures and the splenectomies did not prove statistically different

from normal rats when monitored at 2-week intervals.

The 17-ketosteroids are steroids of 19 carbon atoms with a keto group attached to the C 17 position. Urinary 17-ketosteroids are metabolites of adrenal androgens and cortisol both of which are secreted by the adrenal cortex. Rats secrete corticosterone almost exclusively and only traces of cortisol (Ganong, 1973). Therefore, urinary 17-ketosteroids in a rat are reliable indicators of the secretion of adrenal androgens except testosterone, which is not a 17-ketosteroid, and do not reflect adrenal glucocorticoid secretions (Best & Taylor, 1973; Greep & Astwood, 1975). Thus, measurement of urinary 17-ketosteroids monitors androgenic activity in rats. Results indicate that after adrenal transplantation, cortical production of androgens increased by over 50% for six weeks and finally leveled off at 40% above the normal level (Figure 1). This is indicative of hyper-function of the transplanted adrenal cortex. The cancer constitutes a continuous stress and values are 30% higher than normal values for six weeks in the cancer group (Figure 1). Thereafter, values diminished drastically due to adrenal exhaustion with chronic stress (Ganong, 1973). The levels for the cancer group after adrenal auto-transplantation reflect again the effects of transplantation on cortical tissue and slightly exceed levels of the other adrenal transplant group because of the effects of the cancer stress (Figure 1).

The concentration of BUN is directly proportional to the nitrogen turnover or deamination of amino acids by the liver (Bell *et al.*, 1968). Glucocorticoids, a secretion of the adrenal cortex, mobilize amino acids and influence hepatic metabolism by stimulating the uptake of amino acids by the liver and the synthesis of a number of hepatic enzymes (Wolstenholme & O'Connor, 1960; Greep & Astwood, 1975). The activities of enzymes in the urea cycle are thus increased and, therefore, there is an increased conversion of amino nitrogen to urea. This increase in blood urea is directly proportional to BUN increases (McLean & Gurney, 1963). After adrenal auto-transplantation, BUN levels are elevated and thus indicate an increase in glucocorticoid secretion by the adrenal cortex. This further confirms that the transplanted cortex is hyper-functioning with respect to glucocorticoids (Figure 2). Cancer rats had reduced BUN levels as is the case with most chronic wasting diseases in rats (Figure 2). Cancer rats, after adrenal transplantation, had elevated BUN levels which again indicate increased adrenal cortical function (Figure 2).

The apparent regression or decreased growth rate of the granulosa-theca cell tumor after adrenal auto-transplantation must be related to increased activity of the adrenal cortex after transplantation. Quite possibly the increased production of androgens and glucocorticoids triggers an immune response to the cancer.

ACKNOWLEDGEMENTS

The authors wish to thank Dr. Tom Denton, Dr. Ellen McLaughlin, Ira Gore, Jr., Dr. Ira Gore, and Dr. Hazel Gore for their valuable assistance in this project.

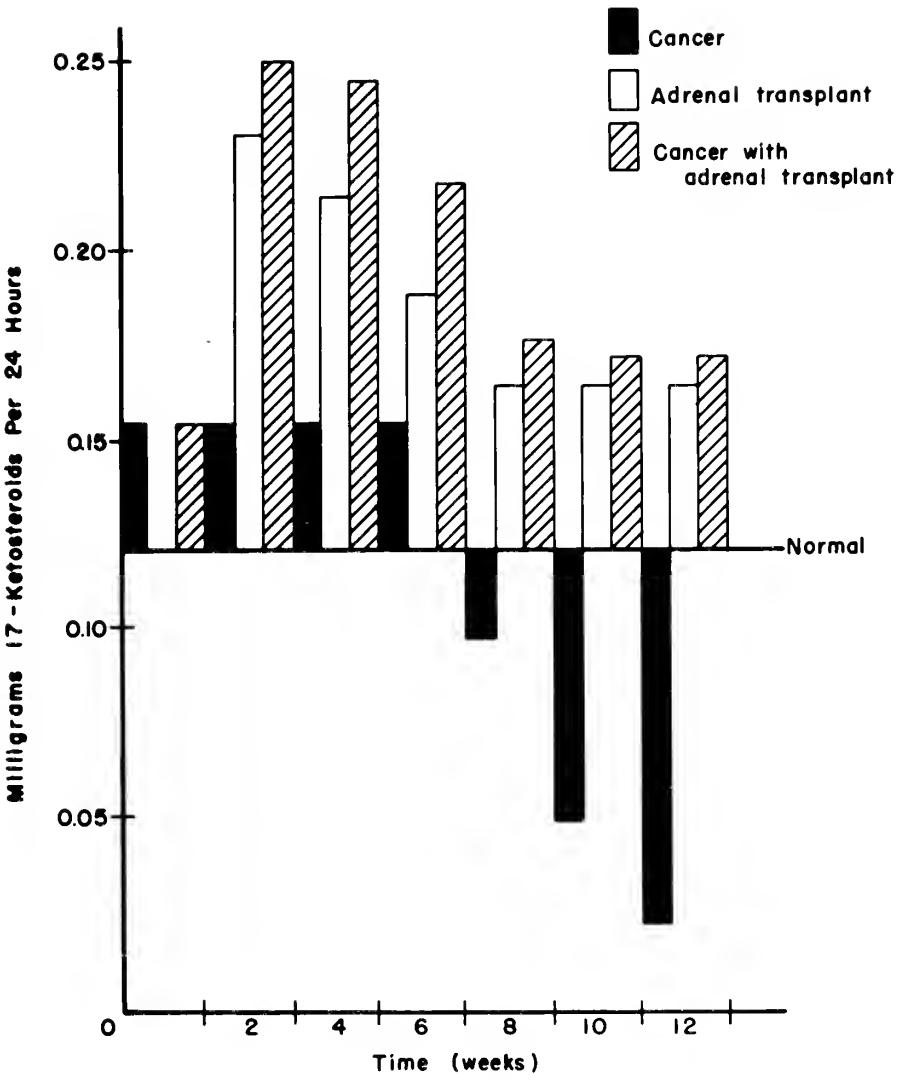

Figure 1. A comparison of levels of urinary excretion of 17-ketosteroids in cancerous and non-cancerous rats both with and without adrenal auto-transplants. The 17-ketosteroid levels were measured at two-week intervals over a period of 12 weeks.

Table 1.

Ninety-five percent confidence limits for the urinary excretion of 17-ketosteroids expressed in mg/24 hrs.

Experimental Group	Time in weeks						
	0	2	4	6	8	10	12
Normal	0.12±.019	0.12±.015	0.12±.016	0.12±.022	0.12±.012	0.12±.018	0.12±.019
Adrenal transplant	0.12±.016	0.23±.024	0.22±.015	0.19±.013	0.17±.021	0.17±.022	0.17±.019
Cancer	0.16±.	0.16±.	0.16±.017	0.16±.019	0.10±.013	0.05±.015	0.025±.018
Cancers with adrenal transplant	0.16±.021	0.25±.023	0.25±.020	0.22±.016	0.18±.014	0.17±.013	0.170±.011

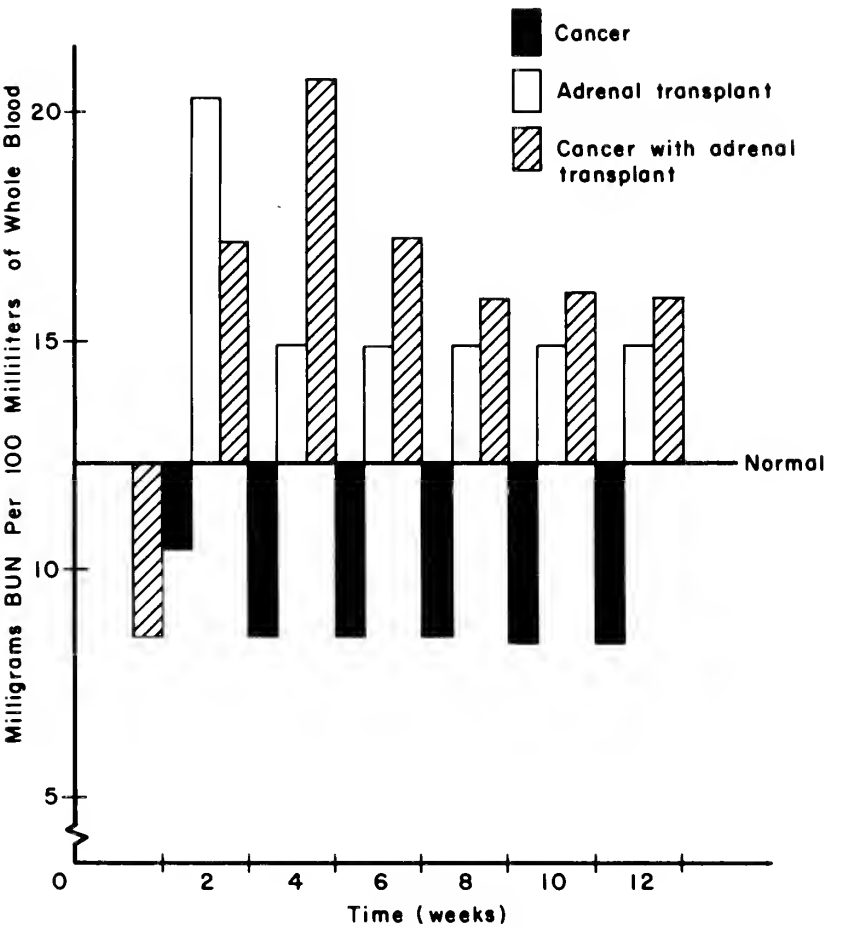

Figure 2. A comparison of Blood Urea Nitrogen levels in cancerous and non-cancerous rats both with and without adrenal auto-transplants. BUN levels were measured at two-week intervals over a period of 12 weeks.

Table 2.

Ninety-five percent confidence limits for blood urea nitrogen levels expressed in mg/100 ml of whole blood.

Experimental Group	Time in weeks						
	0	2	4	6	8	10	12
Normal	12.4±0.63	12.4±0.89	12.4±0.96	12.4±0.58	12.4±1.10	12.4±0.61	12.4±1.00
Adrenal transplant	12.4±1.30	20.3±2.10	17.2±1.40	15.0±1.23	15.0±1.60	15.0±0.92	15.0±0.64
Cancer	12.4±1.20	10.5±1.60	8.6±0.85	8.6±0.53	8.5±0.91	8.5±1.20	8.4±0.77
Cancers with adrenal transplant	8.6±1.10	17.2±2.00	20.8±2.30	17.4±1.70	16.6±0.83	16.2±0.63	16.0±0.74

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CRESOL INDUCED GROWTH INHIBITION IN CULTURES OF CHICK FIBROBLASTS AND *ANKISTRODESMUS*

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INTRODUCTION

The effects of ortho-, meta-, and para-cresol have been studied mostly from the standpoint of their toxicity to whole organisms (Patrick, *et. al.*, 1968; Howland, 1969; Diechmann and Witherup, 1944). All three isomers are commonly found in the environment in the form of antiseptics, disinfectants and water pollutants (Klein, 1957). Data concerning the effects of cresols on cellular growth of plants and animals are inconclusive. This study is to determine the effects of the three isomers of cresol on a representative animal and plant cell system in which environmental factors can be rigidly controlled. The system chosen for animal cells was chick embryo fibroblasts grown in tissue culture, and for plants, cultures of the unicellular green alga *Ankistrodesmus falcatus*.

METHOD

Chick fibroblasts were cultured and harvested using standard procedures (Priest, 1969). Each culture had a final volume of 10 cc and was routinely harvested 96 hours after seeding. Each cresol isomer was tested by adding 5, 10, 20, or 50 ug/cc of culture medium 24 hours prior to harvesting. Relative growth rates were determined by counting the number of metaphase chromosome spreads per 250 cells after exposure to colchicine for the last 6 hours. At least 2,250 cells were scored for each experimental treatment.

Axenic cultures of *Ankistrodesmus* were grown according to procedures described elsewhere (Deason and Bold, 1960). Experimental cultures were prepared by inoculating 500 cells/cc of algae in the log phase of growth into 40 cc of nutrient medium. Cresols were added in concentrations 1, 10, 25, 50, 100, 500, and 1000 ug/cc of culture medium. Growth was monitored daily for 10 days by recording optical densities at 660 nm.

RESULTS

The growth of chick embryo cells was inhibited by all three isomers of cresol (Table 1). The extent of growth inhibition was similar for each isomer. Beginning at 10 ug/cc, vacuoles were formed in the cytoplasm, especially around the nucleus, and at 20 ug/cc, the vacuoles increased in size and number with the surrounding cytoplasm becoming noticeable granular. The cytoplasm was completely lysed at 50 ug/cc whereas the nucleus remained intact at 10 and 20 ug/cc, showing signs of dissociation at 50 and 100 ug/cc. The chromosome-breaking effects of the cresols at all concentrations were insignificant. The sub-lethal

dose for each of the cresols in chick fibroblasts appears to be 20 ug/cc with the lethal dose being somewhere between 20 and 50 ug/cc. Attempts to subculture primary fibroblasts, with or without exposure to cresol, were unsuccessful.

Table 1. The effects of ortho-, meta-, and para-cresol on the growth rates of chick fibroblasts

		Number of Cells		
Treatment		Interphase	Metaphase	% Metaphase
Control		25,351	1,649	6.10
Ortho-cresol	5 ug/cc	8,794	206	2.28
" "	10 ug/cc	15,507	243	1.54
" "	20 ug/cc	6,714	36	0.53
" "	50 ug/cc	2,250	0	0.00
Meta-cresol	5 ug/cc	6,605	145	2.15
" "	10 ug/cc	11,069	181	1.61
" "	20 ug/cc	6,718	32	0.47
" "	50 ug/cc	2,250	0	0.00
Para-cresol	5 ug/cc	4,401	99	2.20
" "	10 ug/cc	8,884	116	1.28
" "	20 ug/cc	4,482	18	0.40
" "	50 ug/cc	2,250	0	0.00

All three cresols decreased the growth rates of *Ankistrodesmus*, but to different degrees (Table 2). Cells were little affected at 1 and 10 ug/cc. At 25 ug/cc, meta-cresol was not inhibitory but ortho- and para-cresol decreased growth slightly. At 50 ug/cc concentration, growth was drastically reduced with ortho-cresol but only slightly so with meta- and para-cresol. All isomers severely inhibited growth at 100 ug/cc, and at 500 ug/cc and beyond, no growth occurred at all. Cytologically, the cells appeared abnormally shaped and lysed between 100 and 1000 ug/cc. The number of abnormal cells increased with added amounts of cresol. The median tolerance limit (MTL), or sub-lethal concentration, for meta- and para-cresol was 100 ug/cc, and for ortho-cresol, 50 ug/cc. Cells subcultured in cresol free media after 10 days resumed growth when taken from original cultures containing concentrations of cresol through 100 ug/cc. Cells did not recover after 10 days exposure to concentrations of either 500 and 1000 ug/cc.

Table 2. A comparison of the growth rates of *Ankistrodesmus falcatus* in various concentrations of meta-, ortho-, and para-cresol

Concentration (ug/cc)	The slope as an index of growth rate[a]		
	Meta-cresol	Ortho-cresol	Para-cresol
1	0.39	0.39	0.38
10	0.41	0.37	0.34
25	0.37	0.25	0.29
50	0.33	0.15[b]	0.26
100[b]	-0.10	0.01	-0.03
500[c]	0.10	0.04	0.07
1000[c]	0.01	0.00	0.01

[a]Each value represents 6 daily measurements over a 10-day period.

[b]Sublethal concentration

[c]Lethal concentration

CONCLUSIONS

Comparatively, cells of *Ankistrodesmus* have approximately three times the tolerance to cresols as do cultured chick cells. Both cell systems reacted similarly as concentrations were increased, displaying abnormal shapes and eventual lyses. All three isomers induced similar effects in each of the two respective systems except ortho-cresol, in *Ankistrodesmus*, appeared to be more toxic than the other two isomers. It is not known why this isomer is more toxic when the methyl group is in the ortho position.

The destructive mechanism of action of cresols on living cells is not well understood. Some investigators have reported that it denatures protein (Goodman and Gilman, 1965; McLachlan and Craigie, 1960). This contention is supported by observations from this study. Increased vacuolation signifies cell deterioration. It is reasonable to assume that cresol-induced vacuole formation is the result of altered structure at cytoplasmic membranes. The denaturation of the protein moiety of these membranes would imbalance permeability, resulting in uncontrolled functions. The specific membraneous organelle implicated in this study is the golgi apparatus since vacuolation was most prevalent in proximity to the nucleus.

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FUNGI OF ALABAMA. V. DEMATIACEOUS HYPHOMYCETES

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INTRODUCTION

A continued survey of microfungi occurring in soil and on herbaceous and lignaceous substrates has yielded many more collections of hyphomycetes. Ten species are described and illustrated herein. Five of these occur on corn.

TAXONOMIC PART

Curvularia eragrostidis (P. Henn.) J. A. Meyer, Publ. Inst. nat Etude agron Congo belge, Sér. sci., 75:183, 1959 (Fig. 1).

≡ *Brachysporium eragrostidis* P. Hennings, Annls Mus. R. Congo belge, Bot., V, 2:230, 1908.

Colonies effuse, black, hairy. Mycelium immersed in the substratum, occasionally partly superficial, composed of branched, septate, smooth-walled, pale brown hyphae, 2-5.5µ wide hyphae. Conidiophores macronematous, mononematous, flexuous, or sometimes straight, often geniculate in the upper part, simple, pale brown to brown, paler towards the tip, septate, smooth-walled, somewhat bulbous at the base, 140-380 X 3-10µ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial, cylindrical, occasionally very slightly swollen. Conidia solitary, acropleurogenous, simple straight, ellipsoidal, 3-septate, smooth-walled, middle septum truly median and appearing almost black, central cells mid brown to brown, end cells paler, basal hilum discernible but not protuberant, 22-29 X 11-17µ.

Isolated from soil, Auburn, Lee County, Alabama, July 1975, G. Morgan-Jones, AUA; on *Zea mays*, Camp Hill, Tallapoosa County, Alabama, July 1975, G. W. Karr Jr., AUA.

An isolate of this fungus from pineapple *(Ananas comosus)*, has also been examined, Zambia, August 14, 1973, B. K. Patel, IMI 1783812, AUA.

Curvularia geniculata (Tracy and Earle) Boedijn, Bull. Jard. bot. Buitenz., III, 13:129, 1933 (Fig. 2).

≡ *Helminthosporium geniculatum* Tracy and Earle, Bull. Torrey bot. Club, 23:207, 1896.

(*Curvularia* state of *Cochliobolus geniculatus* Nelson, Mycologia 56:778, 1964).

Colonies effuse, black, hairy to cottony. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown to brown,

smooth-walled, 3-8μ wide hyphae; some hyphal cells swollen, subglobose to globose and chlamydospore-like, up to 15μ wide. Conidiophores macronematous, mononematous, sometimes arising in groups, straight or flexuous, occasionally geniculate in the upper part, brown, paler towards the apex, simple, septate, smooth-walled, frequently bulbous at the base, 180-440 X 2.5-8μ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial, cylindrical. Conidia solitary, acropleurogenous, simple, usually distinctly curved, broadly fusiform, 4-septate, smooth-walled, brown, central cell darker than the end cells, 22-30 X 8-13μ.

On *Sorghum vulgare*, Camden, Wilcox County, Alabama, July 1975, R. T. Gudauskas, AUA; on *Zea mays* (var. Coker 77), Camden, Wilcox County, Alabama, July 1975, R. T. Gudauskas, AUA. The following two collections from the tropics have also been examined; on *Argemone mexicana*, India, September 5, 1972, K. S. Bilgrami, IMI 168818, AUA and on *Citrullus vulgaris*, Sampadi, Malaysia, April 1, 1973, K. T. Keng, IMI 172113, AUA.

The type collection of *C. geniculata* was made on *Eragrostis rachitricha*, grown from imported seed, Starkville, Miss., October 1894 (Tracy and Earle, 1896).

Drechslera maydis (Nisikado) Subramanian and Jain, Curr. Sci., 35:354, 1966 (Fig. 3).

≡ *Helminthosporium maydis* Nisikado, Sci. Res. Alumni Assoc. Morioka agric. Col. 3:46, 1926.

(*Drechslera* state of *Cochliobolus heterostrophus* (Drechsler) Drechsler, Phytopathology 24:973, 1934).

Colonies effuse, black, hairy. Mycelium partly immersed in the substratum, partly superficial, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 3-7μ wide. Stromata dark brown to black, flattened. Conidiophores macronematous, mononematous, arising usually in small groups, frequently from the stromata, straight below, flexuous above, sometimes geniculate, brown, paler towards the apex, septate, smooth-walled, 230-570 X 4.5-9.5μ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial. Conidia solitary, acropleurogenous, simple, fusiform, distinctly curved, 6 to 9-septate (pseudoseptate), smooth-walled, pale to mid brown, 70-111 X 15-19μ.

On *Zea mays*, Camp Hill, Tallapoosa County, Alabama, July 1975, G. W. Karr Jr., AUA; on *Z mays* (var. Funk G), Camden, Wilcox County, Alabama, July 1975, R. T. Gudauskas, AUA.

D. myadis is the causal organism of southern leaf blight of corn resulting in severe, elongate, cinnamon-buff lesions on leaves.

Drechslera ravenelii (Curtis) Subramanian and Jain, Curr. Sci. 35:354, 1966 (Fig. 4).

≡ *Helminthosporium ravenelii* Curtis, Am. J. Sci. Ser. 2, 6:352, 1848.

Colonies compact, felty, olivaceous brown to black, in inflorescences. Mycelium immersed in the substratum, composed of branched, septate, subhyaline to very pale brown, smooth-walled hyphae, 2.5-4μ wide. Conidiophores macronematous, closely packed, flexuous, geniculate above, frequently once or twice branched, pale brown, bearing distinct, dark scars at conidiogenous loci, 280-520 X 5-8μ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial, frequently nodose. Conidia solitary, acropleurogenous, simple, straight or very distinctly curved, ellipsoidal, obtuse at both ends, 3 to 4-septate (pseudoseptate), smooth-walled, pale brown, 50-60 X 15-18μ.

On *Sporobolus poiretii*, East Tallassee, Tallapoosa County, Alabama, October 28, 1975, P. S. Plotka and G. Morgan-Jones, AUA; Auburn, Lee County, Alabama, November 30, 1975, G. W. Karr Jr., AUA.

Two previous records of this from Alabama are; Auburn, June 1890, G. F. Atkinson (Atkinson, 1897) and Macon County, October 1896, Carver (Mohr, 1901).

A collection has also been examined on *Sporobolus indicus*, Tallahassee, Florida, November 21, 1914, E. Bartholomew, Fungi Columbiani 4633.

Drechslera rostrata (Drechsler) Richardson and Fraser, Trans. Br. mycol. Soc. 51:148, 1968 (Fig. 5).

≡ *Helminthosporium rostratum* Drechsler, J. Agric. Res. 24:724, 1923.

Colonies effuse, black, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown, smooth-walled hyphae, 3-4μ wide. Conidiophores macronematous, mononematous, usually arising singly, occasionally in small groups, straight or flexuous, sometimes somewhat geniculate in the upper part, brown, paler towards the apex, septate, smooth-walled, frequently bulbous at the base, 70-180 X 5-7μ. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial. Conidia solitary, acropleurogenous, simple, straight or slightly curved, obclavate, rostrate, 7 to 12-septate (pseudoseptate), smooth-walled, brown, end cells very pale brown and delimited by thick dark septa, hilum protuberant, 54-124 X 14-22μ.

On *Zea mays*, Fairhope, Baldwin County, Alabama, July 1975, R. T. Gudauskas, AUA.

D. rostrata produces small, pale yellow lesions on leaves of corn.

Drechslera turcica (Pass.) Subramanian and Jain, Curr. Sci. 35:355, 1966 (Fig. 6).

≡ *Helminthosporium turcicum* Pass., Boll. Comizio Agr., Parma, No. 10, 1876.

(*Drechslera* state of *Trichometasphaeria turcica* Luttrell, Phytopathology 48:281-287, 1958).

Colonies effuse, dark olivacous, hairy. Mycelium mostly immersed in the substratum composed of branched, septate, pale brown, smooth-walled hyphae, 3.5-5μ wide. Conidiophores macronematous, mononematous, arising singly or in small groups of two or three, straight or flexuous, brown, paler towards the apex, septate, smooth-walled, 90-230 X 7-9.5μ wide. Conidiogenous cells monotretic, integrated, terminal. Conidia solitary, simple, straight or very slightly curved, ellipsoidal to obclavate, 5 to 6-septate (pseudoseptate), smooth-walled, pale yellowish-brown, hilum protuberant, 90-105 X 17-20μ.

On *Zea mays*, Auburn, Lee County, Alabama, July 22, 1975, R. T. Gudauskas, AUA.

Three early records of this from Alabama exist; on *Sorghum halapense*, Mobile, July 24, 1890; on *Cinna arundinacea*, Auburn, September 15, 1891; on *Elmus* sp. (no locality), July 5, 1890 (Atkinson, 1897). The determinations on which these records are based have not been verified by us.

D. turcica is the causal organism of northern leaf blight of corn resulting in elongated buffish to tan-colored lesions.

Lylea catenulata Morgan-Jones, Mycotaxon 3:130, 1975 (Fig. 7).

Colonies effuse, thin, olive brown, with scattered, branched conidial chains. Mycelium partly superficial, partly immersed, composed of branched, septate, pale brown, smooth-walled or minutely verruculose hyphae, 1.5-2.5μ wide. Conidiophores micronematous or semi-macronematous, inconspicuous, formed as short, erect, cylindrical branches of the superficial mycelium, simple, pale brown, smooth-walled. Conidiogenous cells monoblastic, integrated, determinate; constituting the conidiophore, terminal or intercalary on conidia, or intercalary on hyphae. A second conidium is formed apically from the terminal cell of the conidium, following which conidia may be produced from the second and subsequent conidia at terminal and intercalary loci. Conidia catenate, dry, acrogenous, formed in short, frequently branched, acropetal chains, seceding readily, simple, straight or slightly curved, cylindrical, obtuse at each end, thick-walled with narrow cell lumina, guttulate, mid to dark brown, smooth, 1 to 11-septate (pseudoseptate, with thick, dark, conspicuous lamellae), 18-120 X 7-9μ.

On twigs of *Pinus taeda*, Auburn, Lee County, Alabama, August 1973, G. Morgan-Jones, BPI, AUA.

Helicosporium pannosum (Berk. and Curt.) R. T. Moore, Mycologia 49:582, 1957 (Fig. 8).

≡ *Drepanospora pannosa* Berkeley and Curtis, apud Berkeley, Grevillea 3:105, 1875.

(*Helicosporium* state of *Tubeufia helicoma* (Phill. and Plowr.) Pirozynski, Mycol. Pap. 129:30, 1972).

Colonies effuse, dense, olive to olive brown, velvety to felty. Mycelium partly immersed in the substratum, partly superficial, composed of branched, smooth-walled, pale brown to brown hyphae, 3-9µ wide; cells of hyphae sometimes irregularly swollen and contorted. Conidiophores arising from the superficial hyphae. macronematous, mononematous, simple, straight or very slightly flexuous, stout, setiform, erect, thick-walled, septate, pale yellowish brown to brown, much paler towards the tip, extreme apex subhyaline and acutely pointed or obtuse, 65-190 X 5-9µ. Coniodiogenous cells monoblastic or polyblastic, integrated, intercalary, producing lateral, peg-like, subhyaline to hyaline outgrowths at whose tip the conidiogenous loci are located; each outgrowth gives rise to a single terminal conidium or may proliferate sympodially to give rise to a second conidium. Conidia solitary, dry, simple, helicoid, 1-3 times coiled in one plane, subhyaline to very pale brown, septate, minutely echinulate, obtuse to acute at the apex, subtruncate at the narrow base, attachment scar eccentric, 75-180µ in diameter, filaments 3-11µ wide. Secondary conidia frequently formed as small, lateral, subglobose vesicle-like outgrowths from the inner wall of one or two cells of the conidia, subhyaline and thin-walled below, brown and thick-walled above, 5-7µ in diameter.

On unidentified twig, Chewacla State Park, Lee County, Alabama, August 1974, G. Morgan-Jones, AUA.

A number of perithecia of the perfect state were found associated with the conidial state and will be reported upon in another paper in this series dealing with ascomycetes.

Periconia echinochloae (Batista) M. B. Ellis, Dematiaceous Hyphomycetes, Commonwealth Mycol. Inst. 347, 1971 (Fig. 9).

≡ *Periconiella echinochloae* Batista, Bolm. Secr. Agric. Ind. Com. Est. Pernambuco 19:174-175, 1952.

Colonies effuse, black, hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown hyphae, 2-5.5µ wide. Conidiophores macronematous, mononematous, arising singly or in small groups from stromatic tissue developed as a largely superficial plate of supporting cells, erect, straight, branched towards the apex, brown to dark brown, thick-walled, septate, cylindrical, smooth, bearing a terminal, loosely compacted head of conidia. Stipe 320-460 X 7-16µ, somewhat bulbous at the base. Conidiogenous cells monoblastic or polyblastic, discrete at the tips of primary and secondary branches, determinate, ellipsoidal, pale brown, with somewhat roughened walls, 7-8 X 4.5-5µ. Conidia acrogenous, simple, ellipsoidal, obtuse at each end, pale yellowish brown to brown, distinctly verruculose, 10-14 X 6-8µ.

On unidentified grass, East Tallassee, Tallapoosa County, Alabama, October 28, 1975, P. S. Plotka and G. Morgan-Jones, AUA.

Pyricularia grisea Saccardo, Michelia 2:20, 1880 (Fig. 10).

Colonies effuse, thinly hairy, pale olivaceous to olivaceous brown. Mycelium immersed in the substratum, composed of branched, septate, very pale yellowish-brown to subhyaline, smooth-walled hyphae, 2-3.5μ wide. Conidiophores macronematous, mononematous, slender, erect, flexuous, somewhat geniculate in the upper part, septate, cylindrical, pale brown, smooth, 48-116 X 2.5-3.5μ. Conidiogenous cells polyblastic, intergrated, terminal, sympodial, bearing a number of lateral denticles; each denticle constituting a separating cell which is delimited from the conidiogenous cell by a septum. Conidia solitary, dry, acropleurogenous, simple, obpyriform to obclavate, hyaline to very pale olivaceous brown, smooth, 2-septate, hilum (part of separating cell) distinctly protuberant, 17-26 X 6-7.5μ.

On *Digitaria sanguinales,* Auburn, Lee County, Alabama, June 23, 1975, G. W. Karr Jr., AUA.

ACKNOWLEDGEMENT

We thank Dr. R. T. Gudauskas for the opportunity to study his collections on corn.

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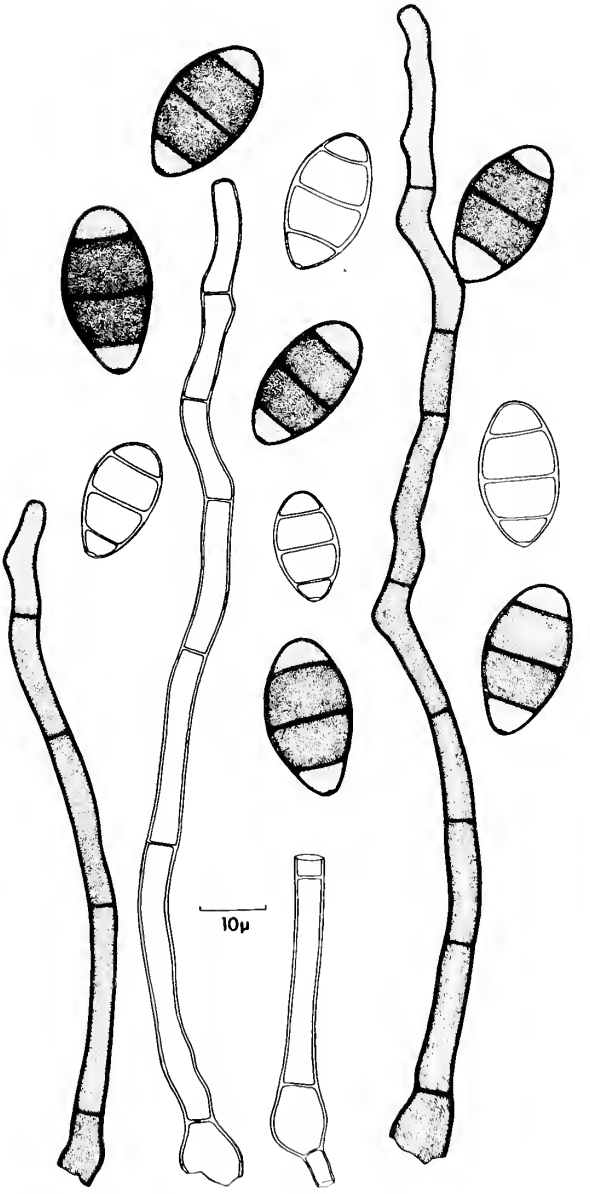

FIGURE 1. *Curvularia eragrostidis*

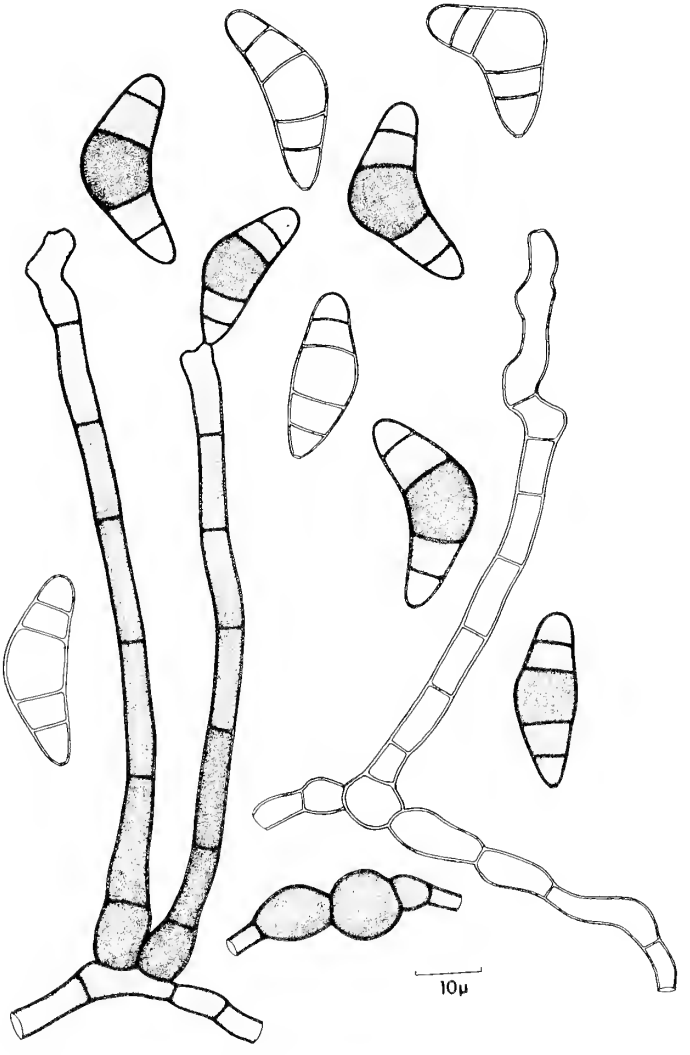

FIGURE 2. *Curvularia geniculata*

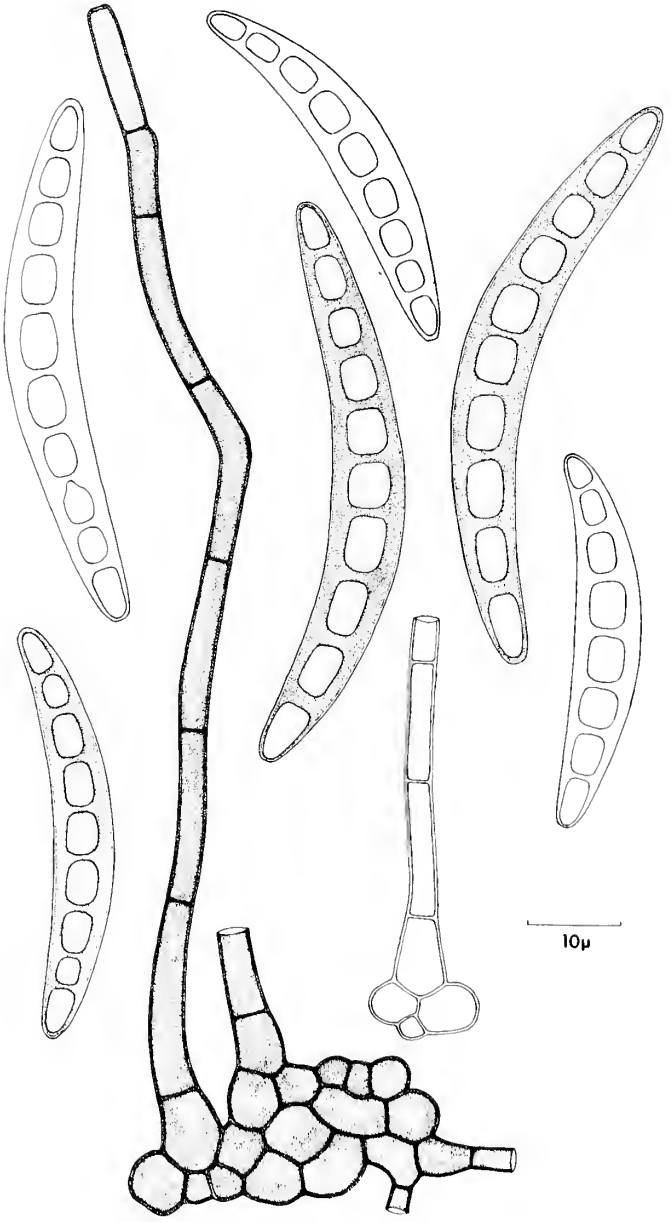

FIGURE 3. *Drechslera maydis*

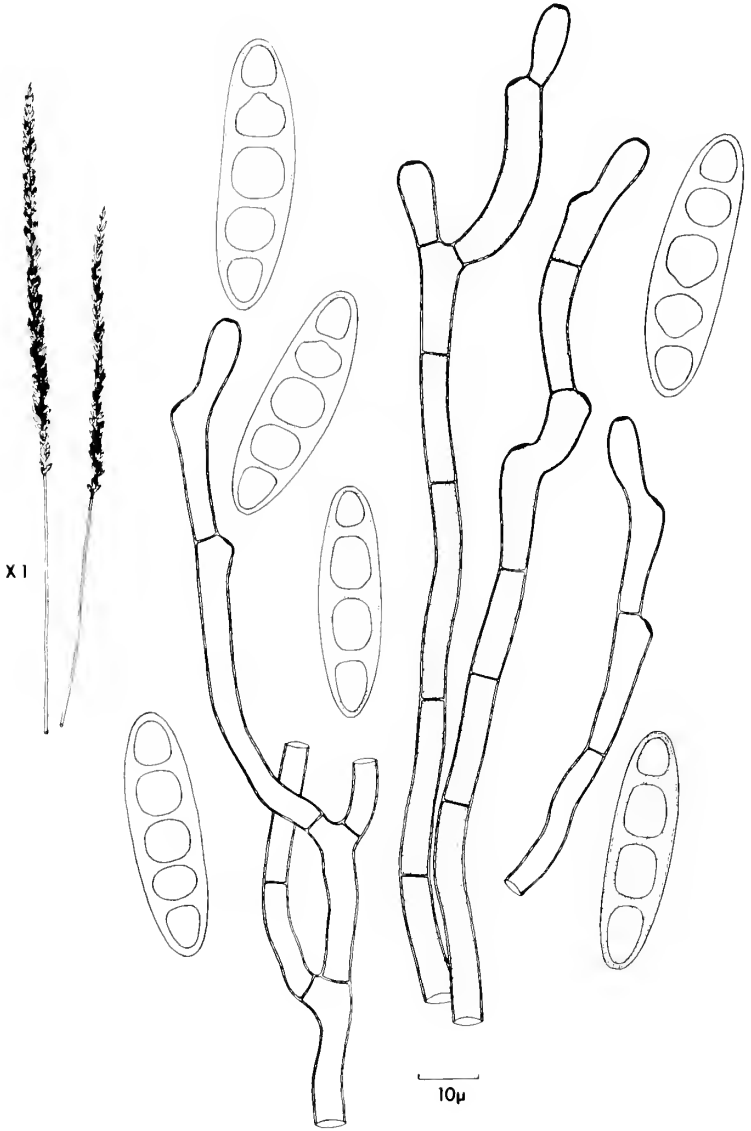

FIGURE 4. *Drechslera ravenelii*

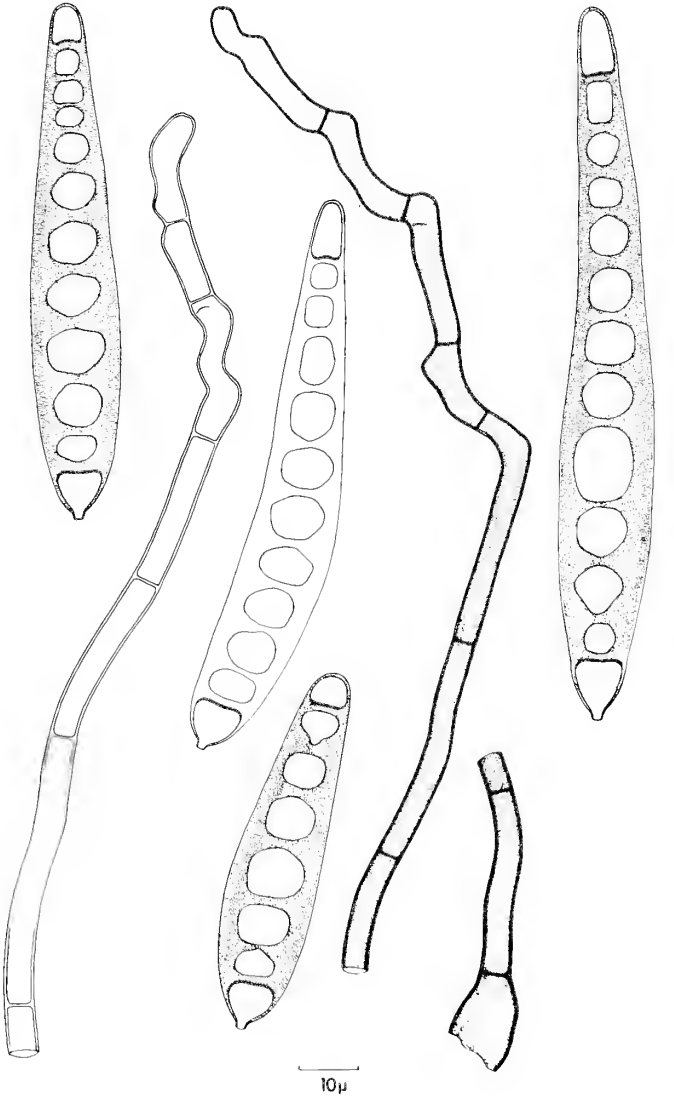

FIGURE 5. *Drechslera rostrata*

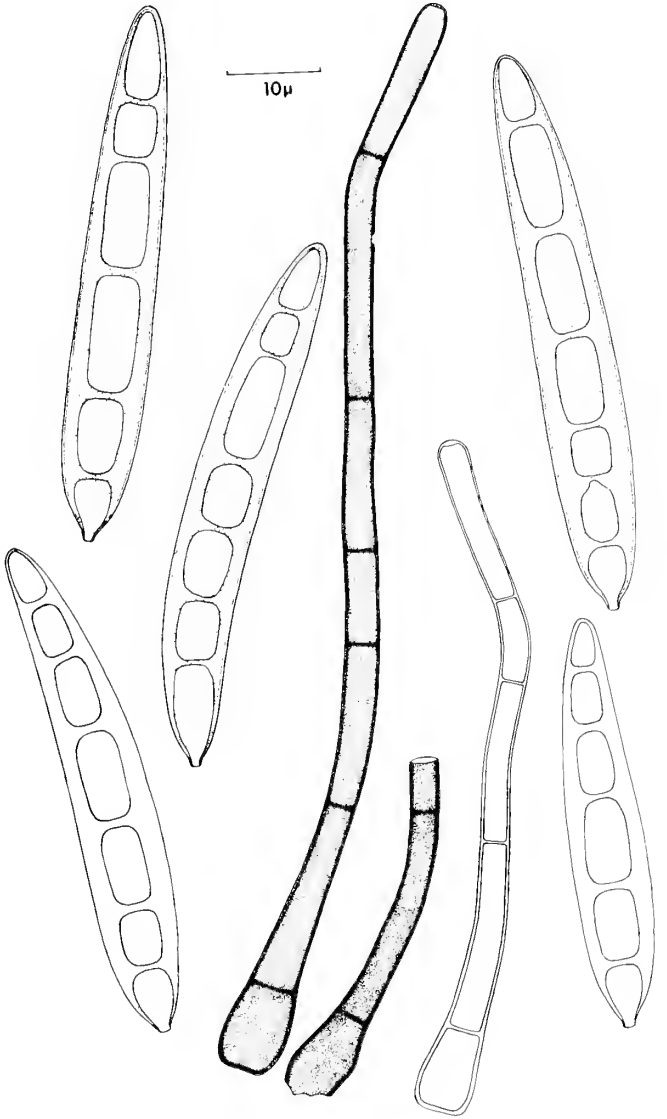

FIGURE 6. *Drechslera turcica*

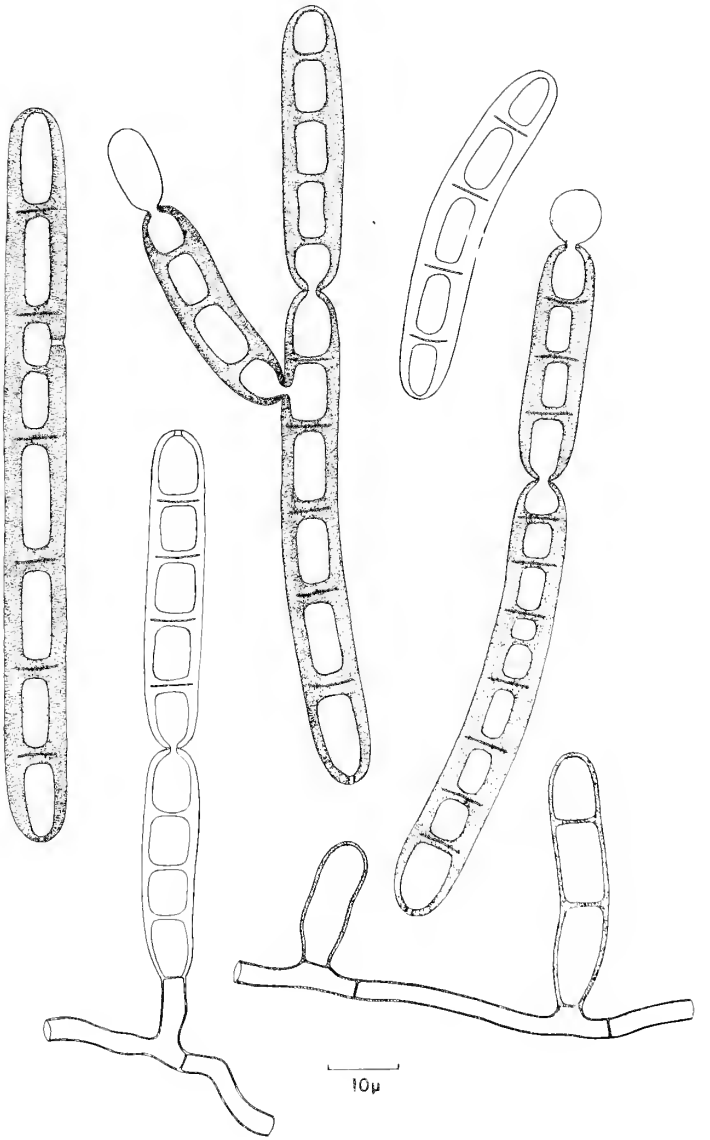

FIGURE 7. *Lylea catenulata*

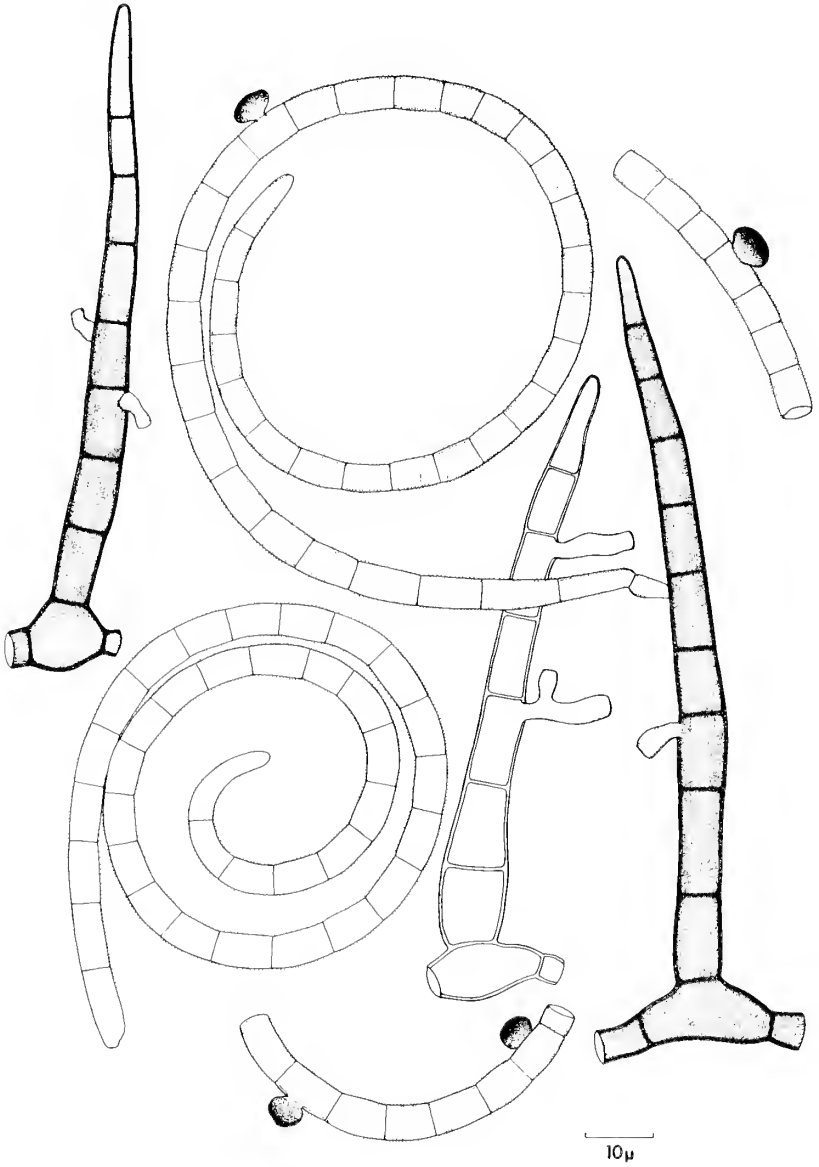

FIGURE 8. *Helicosporium pannosum*

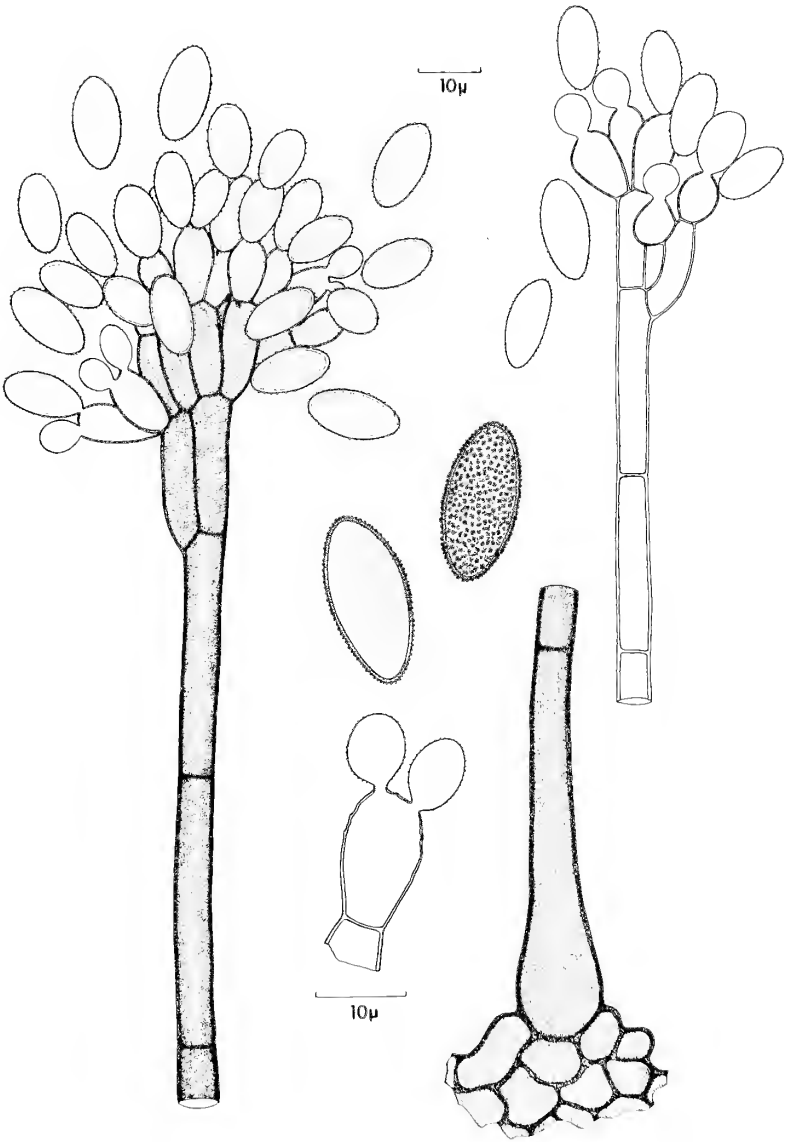

FIGURE 9. *Periconia echinochloae*

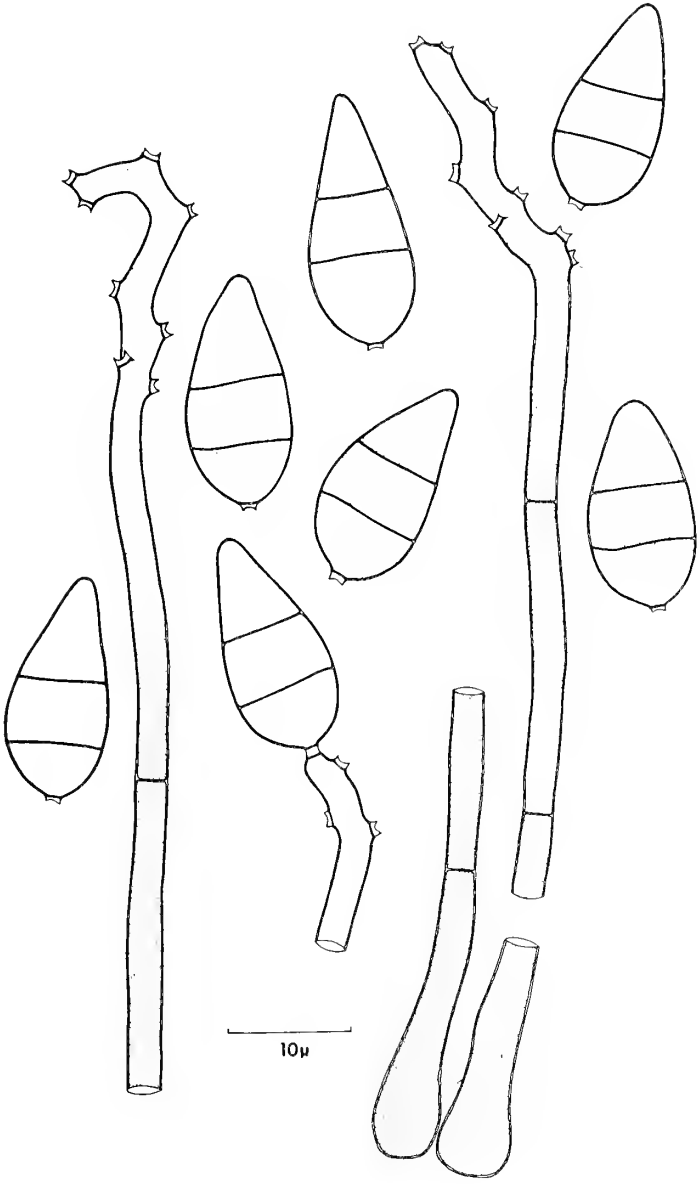

FIGURE 10. *Pyricularia grisea*

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